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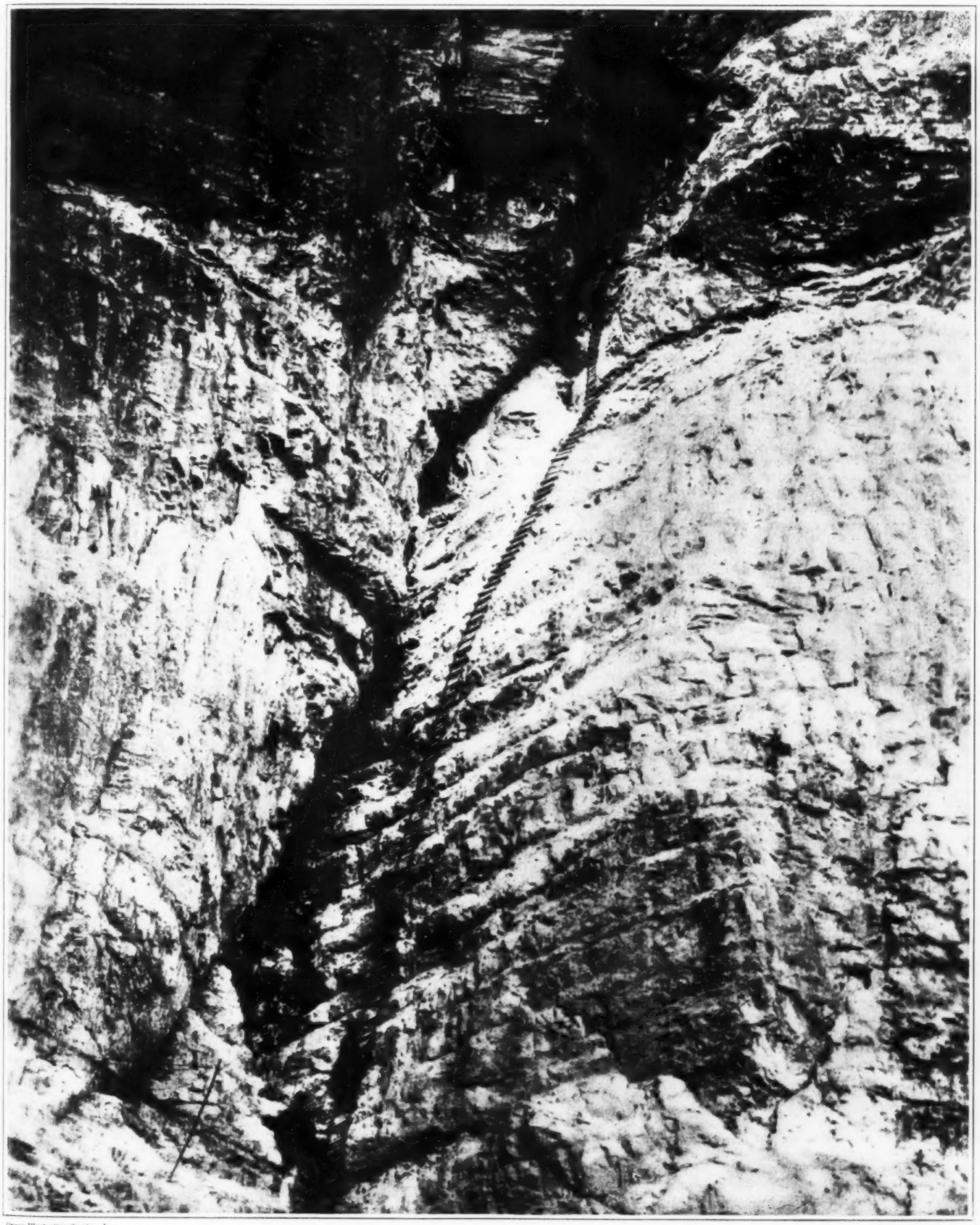

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Long rope ladders leading to observation stations on the heights

WHERE ITALY IS FIGHTING [See page 277]

Human Biology and War

Man and Animals Conform to Different Laws

[*Editorial Note.—One of the notable books published last year in England was the work by Chalmers Mitchell, a distinguished zoologist and member of the Royal Society of London, called Darwinism and War. This work has been recently translated into French, by M. Solovine, with a preface by M. E. Boutroux of the Academy and has been arousing great interest among French biologists.*

The avowed purpose of the book is to demonstrate the fallacy of the contention by certain German thinkers that war is a biological necessity based upon the Darwinian theory of the struggle for existence and the survival of the fittest. The book has brought forth two important articles from eminent French scientists, both of which appear in late numbers of La Revue Scientifique (Paris) which deal with Mr. Mitchell's theories from varying angles and are provocative of thought. We present excerpts from each of these, following a brief analysis of the contents of the book].

MR. CHALMERS MITCHELL'S new book, "Darwinism and War" is a reply to the argument in favor of war, so often put forth in the last three years by a certain German school, that a state of constant struggle or warfare is a dominant factor in evolution. These writers declare that war is both necessary and admirable, and is in fact a biological law which man cannot resist, and that it is, moreover, beneficial in the long run, favoring the survival of the strongest and ablest races. They remind us that all animals, and even all plants, are engaged in a constant battle for the necessities of life, for earth, air, food, water, and a place in the sun. So that it is natural and inevitable that not only men but nations must engage in the same rivalry, which is a means of selection of the fittest.

Darwin, however, never stated this principle as a biological law, but merely as a working hypothesis capable of explaining many facts otherwise obscure. Mr. Mitchell examines at length various examples of the struggle for existence among animals, such as the supplanting of the thylacine, a marsupial about the size of a large fox by the dingo, or wild dog of Australia, the nearly complete extermination of the black rat by the bold and fierce brown rat, etc. His conclusion is that the causes which determine the success of one species in relation to another are variable and often difficult to determine. Such success may be due to a better developed brain, to a greater resistance to microbes, or to a superior capability of adaptation to environment. But he finds no evidence that violence exerted by individuals of the more favored species upon individuals of the less favored species is an important factor. In his own words: "Natural selection results from the conservation of favored races rather than from the extermination of one race by another." He contends moreover that there is an impassable gulf between men and animals residing in the fact that man possesses the consciousness and sentiment of liberty, and that he regulates his conduct by moral laws elaborated through centuries. He finds nothing in common between the grouping of individuals which forms a modern nation and that which constitutes a race or species of animals. In short he believes it is entirely inadmissible to attempt to justify human conduct by laws supposed to be dominant in the animal kingdom.

In his essay entitled "Biology and War" Professor Etienne Rabaud, of the staff of the Sorbonne, points out the alleged error of the Germans in considering brute strength the preponderant factor of evolution, since there are various possibilities which may prevent the victory of the strong over the weak. He writes:

Adversaries do not always encounter each other under the same conditions, and it often happens that the stronger or more skillful is badly placed and therefore perishes. It is true that in open territory, with only his own resources the chances are against the weaker, though he may at times escape by flight. Even so, however, the weakness of the victim may be only relative, as when a young individual of a species better endowed with absolute valor meets an adult of less endowment. . . . Then it often happens that circumstances prevent the individual apparently most advantaged from making use of his advantages, and facilitate the attack of his less advantaged enemy. . . . Cope has expressed the highly probably hypothesis that the disappearance of the huge Jurassic saurians was due to very small mammals who, by destroying the eggs of the former, destroyed the species. Whether this hypothesis be actually true or not, it expresses the essential fact that absolute force is not dominant in biologic phenomena; force is always relative, not only to the individual opponents, but to multiple contingencies, infinitely and constantly variable. This relativity is nowhere more true than among civilized human species where the fate of the strongest always depends on occasion, on complex factors, on those "imponderables" of which there has been so much talk apropos of the present war. . . . The environment, the habits of life, the concourse of divers circumstances often give to the weaker the completest mastery. . . . The inevitable preponderance of brute strength is not and could never be a biologic fact.

Moreover, the German error does not reside solely in the mystical belief in the omnipotence of brute strength, of material superiority, in armed conflict; it resides also in the faith in the omnipotence of force in the most diverse circumstances of life. All their processes of government are founded on the employment of force, and no longer for the suppression pure and simple of feeble individuals or peoples, but to make these accept the law of a strong people. Here selection cannot be invoked under any pretext whatever, for in admitting that the vanquished must submit to the law of necessity, it does not follow that he will be able to deform and transform at the will of the victor so as to resemble the latter. This, however, is the German idea and pretension.

But in thus thinking and practising the German loses sight of a fundamental axiom of biology. It is evident that no organism whatever can be transformed without the modification of the conditions of the life of that organism . . . But an organism—nation, species, or individual—is not a passive plastic mass, capable of taking any given form; each has its own proper nature, and comports itself in accordance with the functions of that nature in the presence of new conditions. Every biologist well knows that in submitting different creatures to similar influences he obtains a series of different results. And nations, like species, have their own temperaments.

Doubtless we can admit, with Chalmers Mitchell, that a species contains only individuals springing from a single stock, while a nation results from the agglomeration of divers elements; but this does not constitute an essential difference, for the heterogeneous elements of a nation are finally fused together by reciprocal action, and acquire a common mentality which will henceforth condition all reactions to foreign influences. The Germans themselves furnish a striking example of this, though composed of races originally different, and even in a measure preserving certain peculiarities, they accept *en bloc* the Prussian discipline symbolized by the goose-step, submitting to the organization so highly vaunted, so useful indeed in certain respects, but so remarkably sterilizing in certain others. Transport this discipline and this organization among other peoples and the individuals will reject it. Impose it by force and you will engender revolt . . . always latent, but ready to break out at the first opportunity. Is it not significant that after forty-five years of domination Germany has not obtained the free adherence of Alsace-Lorraine, and that after more than a century the hatred of Poland for Prussia remains unaltered? Enslaved peoples remain decidedly rebellious to obligatory Kultur. . . In truth, no change in the conditions of life can be followed by adaption unless produced gradually and with respect to the nature of the organisms involved, for no organism whatever is indifferently adaptable to any sort of conditions whatever. This is even truer for man than for most of the other animals and psychologic conditions play a rôle not less important than physiologic ones. . . A simple decree does not transform the mentality of a country nor impose upon it a civilization not made by itself for itself. . . In not recognizing this truism the Germans have committed the most colossal of biologic blunders.

As seen by the foregoing extract M. Rabaud warmly supports Chalmers Mitchell in his main argument. However, he makes one vigorous criticism in these words: "According to Chalmers Mitchell, man differs too greatly from animals to make analogous conclusions legitimate; man possesses conscience and liberty, he knows the moral law, whereby he is radically separated from all animals. In uttering this peremptory affirmative the English zoologist ceases to reason scientifically. To endeavor to separate, from the metaphysical and sentimental point of view, organisms which one is obliged to assimilate from the biologic point of view, is a rather vain undertaking."

But this paragraph incites another eminent biologist, Dr. Grasset, of the Faculty of Medicine of the University of Montpellier, to enter the lists hot-foot to break a lance with M. Rabaud. He thus takes up the challenge:

Without "ceasing to reason scientifically," without adopting "the sentimental and metaphysical point of view," one may declare that man—a fixed species for a very great number of centuries—presents characteristics so specific (notably from the psychical point of view,) that he should rationally be made the subject of a separate science, not to be confounded either with physico-chemistry (the science of inorganic bodies), nor even with general biology (the science of all living creatures). *The science of man, or Human Biology, should be regarded as a true science, positive and experimental, distinct from all others.*

It must be emphasized primarily that Human Biology studies—and studies exclusively—man as a fixed species for a great number of centuries. No one disputes the importance of the question of the origin of species, and of the human species in particular. . . but the fixity of the human species is ancient enough to be accepted scientifically as a *fact*, capable of serving as a point of departure for a special study: the study of man such as he has been for centuries, entirely apart from hypothesis as to his origin and as to his destiny after death.

The *method*, in Human Biology, is positive and experimental, as in all sciences. But this method, when applied to man, must be both *objective* and *subjective*. Biologists generally refuse to employ the method of subjective observation because they fear it will be extended to the lower animals . . . but this anthropomorphic error is not to be feared in a science which confines itself entirely to man . . . The method in Human Biology must also be *physiopathologic*, *i.e.*, its object must be the living man, whether well or ill. . .

All contemporaneous philosophy has been led astray by the researches upon the evolution of species. Instead of pursuing the study of man as a fixed species, an effort has been made to relate all human phenomena, by insensible transitions, to the phenomena presented by all other living beings down to species entirely inferior, or even to the physicochemical characteristics of inorganic substances.

Without doubt comparative biology should not be neglected by the human physiologist; it yields valuable information upon certain functions (digestive, respiratory, nutritive); but as concerns psychic functions (essential and characteristic for man), it can have only a secondary interest. In any case, the laws of Human Biology must concern man alone, and the human biologist must guard himself as carefully against the amibomorphic[1] error as the general biologist guards himself against the anthropomorphic error. . . . In the second place, the object of study should be not merely man, but *the living man*. All authorities are increasingly convinced that the science of man should be oriented toward the *physiologic aspect*, rather than the *anatomical aspect*, as a basis of study.

There are morphologic analogies which indicate the assimilation of all living creatures in a continuous series from the amoeba to mankind; but there are on the other hand, characteristics of function, and particularly of psychic function which are specific to man, making of him a distinct organism. Anatomically the brain of man closely resembles that of the ape, of the sheep, and of many other animals, while its functioning is absolutely different from that of even the most closely related of these. The brain of man is defined by its function. Man is defined by his psychic function. . .

Finally, it is man in both good health and ill that is the subject of study. . . The two domains of health and malady mutually complete and illuminate each other . . . Hence the method in Human Biology must be *physiopathologic*. Human Biology is intimately involved with physiopathology, *i. e.*, with medicine, a fact which gives to physicians a competence in this science which they do not possess in general biology. . . The subject matter of Human Biology is to be considered under the three heads: physicochemical laws, biologic laws, human laws. The latter are to be deduced from the positive knowledge and the scientific analysis of the diverse functions of man, and especially of the psychic function. It is, in fact, this last function which is specifically characteristic of man . . . and the two qualities which suffice to establish a fundamental distinction between man and all other living creatures are *intellectual superiority* and the faculty of indefinite progress.

The first is well demonstrated by man's intellectual mastery of the universe, despite his evident inferiority from all other points of view. This psychic superiority is, and has always been, an essential element of man. The faculty of indefinite progress consists essentially

[1] In this school, says Mitchell, human nature is interpreted in terms of protoplasm.

in the faculty possessed by the psychism of man to accumulate and utilize the psychic discoveries and acquisitions of anterior generations. It is this characteristic which renders science possible. From the discovery of the method of producing and conserving fire to the day of Pasteur all knowledge is linked in the progressive construction of science; all new discoveries are conditioned by the preceding.

As in all fixed species the organs do not change nor improve, but psychic progress is continuous and indefinite, if not in the individual at least in human society.

From those two specific characteristics of man it can be deduced that there are *specifically human biologic laws*. Like all other living creatures man must sustain, defend, and transmit his individual life in order to sustain and defend the life of his species. But as the life of the human species involves not a stationary maintenance of the ancient rules of former generations (as among ants and bees), but continuous and indefinite psychic progress, the human individual must also collaborate as best he can in the indefinite psychic progress which is the biologic law peculiar to humanity, either by his personal labors, or by aiding other men in their personal labor for the progress of humanity: this is *the law of the personal participation of each human individual in the life of the continuous and indefinite psychic progress of humanity*.

Not only does Human Biology thus show that its laws are different from the biologic laws of other animals, but it demonstrates also, quite as positively and scientifically, that *the reactions of man to biologic laws* are likewise different from the reactions of other animals. All living creatures which have psychic neurous execute acts which are not an immediate response to the provoking stimulus, but are truly psychic, acts of *volition*.

But the act of volition of man differs from that of the superior animals in a very important characteristic: while, in the animal, all acts are the direct and necessary result of its constitution and its automatism reacting on its external environment, there appears in man, on the contrary, in his acts of reflection and will, a very *special contingence*, a direct intervention of the individual exerting his will, which prevents the *prediction* of the act of a man as one predicts the acts of animals. It is this, specific to man, which we designate liberty, or *freedom to act*.

In other terms, the animal renders fatal obedience to the biologic laws of his species, while man obeys them only if and when he will . . . This, however, does not prevent man from being the subject of positive science; there is a certain determinism in man as in other creatures, only his is a determinism in which *there powerfully intervenes the personal and peculiar psychic activity of the volitional neuron*, and which decides it. Among the factors of the human act there intervenes the intelligent, sensitive, free, enlightened, will of the subject.

From the preceding it results that for man not only are the biologic laws entirely different, but also they provoke in him *entirely different reactions* from those of other creatures. Thus we perceive that man is the subject of a separate science: Human Biology.

This science proves primarily, as a fact, without discussion of the origin, the existence among all men of the *idea-laws of reasoning* and the *idea-laws of human conduct:* the principle of causality or sufficient reason, the idea of good and evil, of moral obligation and the duty of doing good and avoiding evil, of the right to do one's duty, of responsibility—metaphysical ideas, non-experimental of origin, conditions of all human reasoning and of general human conduct. Then, Human Biology discovers experimentally other idea-laws, whose nature and expression it develops in the same degree that it itself develops: these are the laws of *human biologic finality*.

The idea-laws of the first group are not only universal and necessary, but superior and anterior to experience; *non experimental* and consequently eternal and *immutable*. Those of the second group are, on the contrary, *general and experimental*, and therefore *variable and perfectible* as the science which establishes them. The first constitute a *fixed* element as *old* as humanity itself; the last, on the contrary, are a *new* and *changing element*.

In combining the idea-laws of these two groups. . . the human biologist succeeds—exclusively by positive scientific methods—in erecting a biologic sociology and *morale*, which, based on Human Biology, are not open to the objections offered to moral and social sciences based on general biology.

It will now be clear how we arrive by our own route at conclusions very analogous to those of Chalmers Mitchell. . . it is not the general biologic law of struggle, battle, the victory of the strong, which should be applied to man; it is the law of progress, mutual love and help, collaboration and emulation. And I believe, like Chalmers Mitchell, and unlike Rabaud, that these conclusions can be reached without ceasing to reason scientifically. . . . The moral and social sciences, based thus upon a positive science take on a new and considerable solidity, and must impose themselves with absolute authority not only upon all individuals, but upon all human societies (whose egoism no longer takes the place of law and principle), upon all nations (who must no longer let might supplant right). For Human Biology enjoins international morality as well as individual morality, interindividual and social morality, for times of peace and times of war.

Whatever his religion or philosophy, each must bow, freely but obligatorily, before the laws of human conduct as before the laws of human reason—laws promulgated in the name of positive science, that is, of the only authority which is today undisputed.

Archæology of Mammoth Cave and Vicinity: A Preliminary Report*

By N. C. Nelson, American Museum of Natural History, New York

AMERICAN anthropology appears to have arrived at something like a turning point in its history. The continent has now been covered more or less intensively and on the basis of the collected data both the ethnologists and the archæologists are beginning to publish maps outlining in a tentative way the boundaries respectively of the historic and the prehistoric culture centers. (See W. H. Holmes, also Clark Wissler, *Amer. Anthrop.*, New York, 16, No. 3, 1914; and Wissler in the *Holmes Anniversary Volume*, 1916.) These two maps, as would be expected, while not identical, show a noteworthy correspondence.

The question at once arises: How came these centers of cultural intensification to be? Thus far we have no scientific answer. We may say either that they were originated and developed in place or that they were transmitted from without, or finally—and what is most likely—that they are the products partly of transmission and partly of local origination. In any event the given culture complex did not drop out of the heavens in its perfected form: it has a history and what that history has been is for the archæologist to determine.

That the archæologist can do this service need not be questioned. He has done it—or at least so it appears—in Europe. To some of us his performance is not entirely satisfactory as yet and when he insists that by searching in the New World we shall find the identical state of things which he himself has found in the Old World, we openly rebel.

But having said this we must still allow the European to point with pride to his chronological series and at the same time admit the justice of his criticism to the effect viz., that our own investigations are almost totally deficient in this respect. Our museums abound in choice collections from this and that type locality, but we possess little knowledge of how the diversified cultural traits of which these collections bear testimony came about or what are their antecedent relationships. In so far as we mentally arrange these cultures in order of their complexity beginning, let us say, with the shellmound peoples and ending with the Mayas or the Incas, it is a purely selective procedure, perhaps essentially true but nevertheless devoid of real scientific merit.

It is true that some sporadic efforts at chronological determinations of different sorts have been made, as, for example, by Dr. Uhle in Peru, by Dr. Spinden in the Maya area, by the writer and others in the California shellmounds and by a number of men from different institutions—including the American Museum—in the Trenton gravels, as well as in several of the rockshelters of New Jersey and finally by the writer again in the Southwest. All these attempts are of very limited significance, however, each embracing but an infinitely small segment of the entire cultural curve. Without elaborating on the subject any further, it must be tolerably clear from the foregoing how urgent is the need for problem work in American archæology.

Being convinced of this necessity, the American Museum last summer made a preliminary investigation of some of the Kentucky caverns. Caves and rockshelters, in view of the wonderful returns they have yielded in Europe, are difficult to resist even though they have been tried over and over again in America with practically negative results. The general locality was deliberately chosen as being well south of the limits of glaciation, and in fact in some respects quite comparable to the Lower Pyrenees. The quest was not precisely to find evidence of Paleolithic man; it was merely to ascertain whether in the middle Mississippi region there was any trace of a relatively primitive stage of development that might have given rise to the Moundbuilder culture as we know it at its best. In this the writer, who conducted the investigation, is at least morally certain that he succeeded.

In the spring of the year, after consulting with Prof. Arthur M. Miller of the Geological Department of the State University at Lexington, two series of caves and shelters were inspected: one along the Kentucky River, south of Lexington, and the other along the Green River in the vicinity of Mammoth Cave. Later in the season some trial excavations were carried out in several of the Green River sites and positive results were obtained in two places, viz., in Mammoth Cave and in a small unnamed rockshelter about six miles lower down the river.

The discovery in Mammoth Cave consisted of a stratified relic-bearing deposit ranging from a few inches to about four feet in depth and forming part of the floor debris of the large entrance vestibule. In some places the refuse reached the surface of the cave floor, while in others it was buried under as much as four feet of sterile cave earth and rock laid down unquestionably by modern man. The body of the refuse was composed largely of ashes, being presumably the slow accumulation of aboriginal hearth fires. In this matrix was found a considerable quantity of crushed animal bones among which have been distinguished the deer, beaver, opossum (?), turtle, bat and several birds; as well as numerous shells representing two or three species of fresh-water bivalves—all of it together being nothing more nor less than "kitchen" refuse. Isolated portions of the human frame, such as, for example, the distal end of an adult femur, a small fragment of a pelvic girdle and several teeth, were met with at different levels in the deposit; but the remains are not, as might be supposed, in such a state as to suggest cannibalism. Of artifacts in a stricter sense of the term there were obtained a small series of awls and other pointed implements made from bone and antler, many of them being simply improvised from splinters while a few were as perfect as anything of the sort found in America. The flint specimens consisted of numerous reject flakes (some of them apparently used) and five or six chipped blades, mostly fragmentary. Of workmanship in shell there came to light two perforated pendants and several half-shells that may have served as spoons or scrapers. Finally, there were uncovered three more or less crude pestle-like objects made of limestone. And that was all. Several test trenches were opened at different places and quite a number of cubic yards of the refuse was most carefully worked over, but without avail. Not a trace could be found either of maize or of pottery, or of any of the finer forms of polished stone work otherwise so characteristic of the general region. The absence of these things in Mammoth Cave may be an accident, but if so it is most extraordinary.

The second discovery, as previously stated, was made in a rock-shelter about six miles down the Green River, in the bluff opposite the lower end of Boardcut Island. The place is about three miles in an airline from the Mammoth Cave. Here in the natural floor earth was found a thin stratum of ashes containing bits of flint and also fragments of pottery. A little deeper down was laid bare a stone-grave burial of the type so often met with in that section of the Mississippi basin and generally accepted as of relatively late date. Unfortunately nothing whatever accompanied the interment, and as conditions did not permit digging more than the one test pit no complete artifacts were obtained from the shelter.

The significance of these two isolated horizons of culture, briefly stated, seems to be that we have evidence in the one instance of an agricultural people and in the other of a people who lived mostly if not entirely by hunting. The rockshelter horizon being clearly associable with the later developments in the Moundbuilder area, we must assume the cultural segment in the Mammoth Cave to antedate it. At the same time it should be emphasized, in conclusion, that the Mammoth Cave horizon, in view of the faunistic remains accompanying it, cannot in any absolute sense be regarded as ancient.

*A paper communicated to the National Academy of Sciences by Prof. H. F. Osborn, and republished from the Proceedings of the Academy.

Saving Potatoes By Dynamite

A RESOURCEFUL farmer has found a new way to use dynamite that saved a nearly matured crop of potatoes in a badly flooded field. Unusually heavy rains filled all the neighboring drains and ditches so there was no relief for the flooded field; and in this emergency the owner put down a number of holes eight to twelve feet deep with a post auger, and exploded a charge of dynamite in the bottom of each. This opened up passages into the sandy subsoil through which the surplus water drained rapidly, and the crop was saved, although many nearby crops were ruined by the excess of water standing in the fields.

Surgery for Injured Trees*

How Far To Go in Cavity Filling

By J. J. Levison, M.F., Forester for the City of New York

READERS of *American Forestry* often ask us about cavity filling—just how it should be done, and, what is more important, when to do it and when not to do it. We shall now have a heart to heart talk on this question and see if we cannot come to a mutual understanding on its limitations and advantages.

Generally speaking, there are two classes of cavities: those which are shallow and afford no chance for the accumulation of moisture and those which are deep and afford opportunity for the accumulation of moisture.

The treatment of the *shallow* group of cavities is a very simple one. All soft and decayed wood should be chiseled off so that the water falling on the surface of the wound will naturally run off. The exposed wound should then be thoroughly covered with a coat of coal-tar mixed with creosote; nothing else should be done to it for a year or two, when another coat of tar and creosote may be applied.

In case of *deep* cavities where moisture lodges, the treatment is different. With these we must not only eliminate all decayed and diseased wood but we must also fill the cavity or part of it so as to drain water. The absolute elimination of diseased wood and the prevention of any possible accumulation of moisture are the two main considerations in all cavity filling. This involves considerable experience and knowledge of fundamental principles and for this reason if one has not had enough experience himself it may often be preferable to call upon some one of the tree expert companies. Before filling the cavity, the operator should determine whether it is worth doing the work at all or whether it is more practicable to cut the whole tree or branch off. A cavity may be so permeated with disease or so deep or the tree so old and weak that the entire elimination of disease is impossible; also the condition may be such that the tree or limb may break soon after the filling is put in. In that case it is wiser to sacrifice the tree and not to fill the cavity.

Where, however, a filling can be put in with advantage, the process should consist in removing all diseased wood from it with the free use of the knife, chisel or gouge. It is far better to enlarge the cavity by cutting out every bit of diseased wood than it is to leave a smaller hole in an unhealthy state. Disease left within the cavity will continue its destructive work behind the filling with more vigor than if there had been no filling at all. Where there are boring insects within the cavity, their destruction must be assured before filling is commenced.

When the cavity is absolutely freed from disease and insects, its walls should be washed with corrosive sublimate and covered with white lead or with Bordeaux mixture. The interior should be studded with nails and solidly filled with bricks, stones and cement or with charcoal, bricks, and cement. When that is done, the outer edge of the cavity is interlaced with wire to assist in holding the solid material in place, and a layer of cement, mixed with one-third sand, is then placed over the wire. When dry, this layer should be covered with coal-tar. The exposed face of the filling must not be brought out to the same plane with the outer bark of the tree, but should rather recede a little beyond the growing tissue which is situated immediately below the outer bark. By this method the growing tissue will be enabled to extend over the cement and cover the whole cavity, if it be a small one, or else to grow out sufficiently to overlap the filling and hold it as a frame holds a picture. The growth of this living tissue can be much accelerated by cutting around the border of the orifice immediately before the season of growth commences. Of the many failures in filling cavities, the great majority are due to an incomplete removal of diseased wood, to the cement being flushed out to the surface of the outer bark, or to the want of tar on the outer surface of the filling.

Cavity filling to a limited extent, when properly done, is very useful and conducive of much good. When improperly done or done unnecessarily, it is wasteful and often injurious. Here are a few instances of the unnecessary and improper kind often met with:

One often sees diseased cavities covered with sheets of tin. This allows all decayed wood and fungous growth to remain undisturbed within. Now, no one would think of filling a cavity in a tooth without first removing all decayed matter from the interior of the cavity and then washing it with some antiseptic solution. Still, here were similar operations tolerated on trees with utter disregard for these fundamental principles. The tin coverings did more harm than good, because they merely shut out the sun and wind and added more dampness to the interior, thereby favoring every possible development of disease.

Another instance which came under my observation was an attempt to replace bruised bark with cement.

Filling a tree cavity

It is essential that every bit of decayed and diseased wood shall be cut or scraped out and also that the cavity is filled so as to drain water, for when this work is improperly done it is wasteful and often injurious.

The completed filling

Here the tree cavity is properly filled. The interior, cleansed of all foreign substances, is studded with nails and solidly filled with bricks, stones and cement, the outer edge is interlaced with wire to assist in holding the material in place and the outer layer of cement is covered with coal-tar.

This was repeated on hundreds of trees at a vast cost and with utter failure. The person responsible for this work did not understand the purpose of filling a cavity, for, had he known that the filling should be put there to prevent mositure from lodging within the cavity or to furnish a support for the growing tissue to roll over, he might easily have seen that in this instance there was no chance for moisture to lodge on the perpendicular smooth surface, and that the exposed wood furnished ample support for the growing tissue to roll upon. The application of a little coal-tar to the exposed wood would have been all that was necessary. The cement covering, however, merely favored decay, and when the growing tissue on each side of the wound began to extend, it pushed out the cement.

On still another occasion the owner was investing a large sum in filling cavities in chestnut trees that were at the time badly afflicted with the chestnut disease. The operator should have recognized the presence of the disease; he should have known that there is no remedy for it, and that the speedy death of these trees was inevitable. As it happened, the trees soon began to die, and the impracticability of the treatment became evident.

*From *American Forestry*.

Analysis of Some Sizes and Finishes

ANALYSES have been made of a large number of animal and vegetable products used in the sizing and finishing of various textile fabrics, leather, etc., and certain standards are suggested. *Egg and blood albumin* should be completely soluble in 1 per cent caustic soda and should dissolve readily in water at 45° C.; albumin is liable to adulteration with gelatin (readily detected by means of 1—2 per cent tannic acid), and zinc salts are often added to solutions to increase the viscosity and act as antiseptics. *Carrageen* (*Irish moss*), employed as a thickening agent, should contain 1.4-2.5 per cent *Algin*, obtained by extracting *laminaria* with caustic alkali, and adding alginic acid to the extract, is employed as a substitute for Irish moss; it should contain 4-6 per cent of alginic anhydride. *Gum tragacanth* of good quality gives saponification values from 100-180, water 18-22 per cent, and mineral ash 2.5-3.0 per cent; Indian gum tragacanth gives an acid, transparent mucilage, whereas the genuine gum gives a neutral opaque mucilage (viscous in 1 per cent solution) and a blue coloration with iodine not given by the Indian gum; a higher percentage of volatile acid on hydrolysis than 1.8-2.4 per cent indicates adulteration with the Indian or other gums. *Gum acacia* (*gum arabic*) varies from white and soluble (African) to dark and insoluble (Indian), the usual adulterant being dextrin; it gives a precipitate with basic lead acetate solution not given by gum tragacanth; the acidity is 2.5-3 per cent of free arabic acid. *Gum tragasol* is extracted from the locust bean as a substitute for gum tragacanth. *Casein* is analyzed for moisture, fat (0.2-0.6 per cent), and nitrogen.—Note in *Jour. Soc. Chem. Ind.*, on an article by M. C. LAMB and A. HARVEY in *Jour. Soc. Dyers and Col.*

Some Effects of the Action of Ultra-Violet Light on Cotton

SINGLE-PLY cotton fabric, specially scoured and bleached for use in the manufacture of airship envelopes, was exposed continuously at 30-35° C. to the light from a Cooper-Hewitt mercury vapor lamp placed centrally about one foot above the fabric, which was spread flat on a sheet of 3-ply wood. The upper surface of the fabric became biscuit yellow in color, which shaded off from the center, and was not affected by dilute caustic soda, in which the exposed fabric possessed a high solubility; the exposed material also possessed high cupric-reducing power and capacity for absorbing basic dyestuffs (Methylene Blue), and gave a comparatively large yield of furfural. Ultra-violet light in presence of air and moisture may not improbably act in two ways: by some specific physical action causing disintegration of the cellulose, and by the probable development of ozone—known to convert celluloses into acidic, alkali-soluble products having the properties of oxycelluloses. Comparison of the exposed fabric and a hydrocellulose, prepared by the action of dilute sulphuric acid on cotton, showed considerable differences, whereas the properties of the exposed material closely resembled those of oxycellulose. The strength in the affected portions of the exposed fabric had entirely gone; the appearance of transverse cracks with occasional swollen places similar to the effects produced by excessive action of alkali, were noted. The affected part was much more absorbent and wetted out more readily than the unaffected part of the fabric.—Note in *Jour. Soc. Chem. Ind.*, on an article by C. DORÉE and J. W. W. DYER, in *Jour. Soc. Dyers and Col.*

Eccentricities of Ocean Drift

ALTHOUGH observations of ocean currents were made in the earliest days of which we have any recorded history, they were all of a comparatively local nature, in confined waters or channels, and probably little or nothing was learned of the causes that produced them. The first comprehensive study of the currents of the Atlantic Ocean was begun in 1790, and since that time the work has been continued by many observers, with the result that a very large amount of valuable practical information has been collected relating to the various currents and their causes, and fairly accurate charts have been made of the principal currents. The work, however, is difficult and the causes intricate and varied, and many local variations are constantly found that are hard to understand.

Accurate observations in the open ocean from ships at anchor are very uncertain, owing to the veering and rolling of the ship, and observations by instruments can be relied on only for the deeper currents, as too many local and temporary conditions affect the surface water. These incidental conditions also make observations of drifting wood or bottles very uncertain.

The general scheme of currents depends on prevailing winds and the configuration of the coast and its underwater approaches. Thus we have a well defined set of currents set up by the trade winds; but these are subject to complications resulting from cyclones. Moreover, currents induced by winds are subject to deflection by the direction of the rotation of the earth. Another element that has a considerable effect on ocean currents and their direction is the varying density of the water in different regions, and this results both from the melting of the great quantities of ice from the polar regions, which affects conditions at a great distance from the source, and also evaporation, both of these elements combining to set up vertical circulation of the water that has an appreciable influence on currents.

Taking all of these influences into consideration, it is not surprising that we frequently find very curious local combinations, as are evidenced by the course followed by free drifting objects. An interesting example of erratic drifting is shown in the accompanying chart of the course followed by a large whistling buoy that broke from its moorings on Nantucket Shoals on January 20th, 1915, and roved the sea for nineteen months, guided only by the winds and currents. This buoy, which is built of sheet steel and weighs many tons, is about forty feet in extreme height, of which about twenty-four feet are under water. In the greatest diameter of its body it is about twelve feet across. As it was sighted and reported a number of times its course is quite accurately known. Starting on its cruise it took a southerly course, which it followed with but slight deviation until it reached a point off Cape Hatteras, where it turned eastward, and crossing the Gulf Stream, sailed out to sea, nearly to Bermuda, when it changed its mind and started back for the coast of the United States. After traveling a short distance it was picked up by a passing steamer which towed it for a day, but was compelled to drop it again. Then it started off at a tangent towards South America, in which direction it voyaged for over three months, when it again shifted its course to a general northerly direction, as if seeking to return to its old home station. Various other courses were subsequently followed as if it was uncertain whether it should go to Nantucket or to Bermuda, but it was finally picked up by a second steamer that brought it to harbor at the Ireland Island dock yard, at Bermuda on August 18th, 1916.

As the large body of this buoy projects nearly sixteen feet above the water it offered a considerable surface for the wind to act upon, and consequently the course followed was not entirely governed by the water currents, but by a combination of these and the winds encountered during the many months it was adrift.

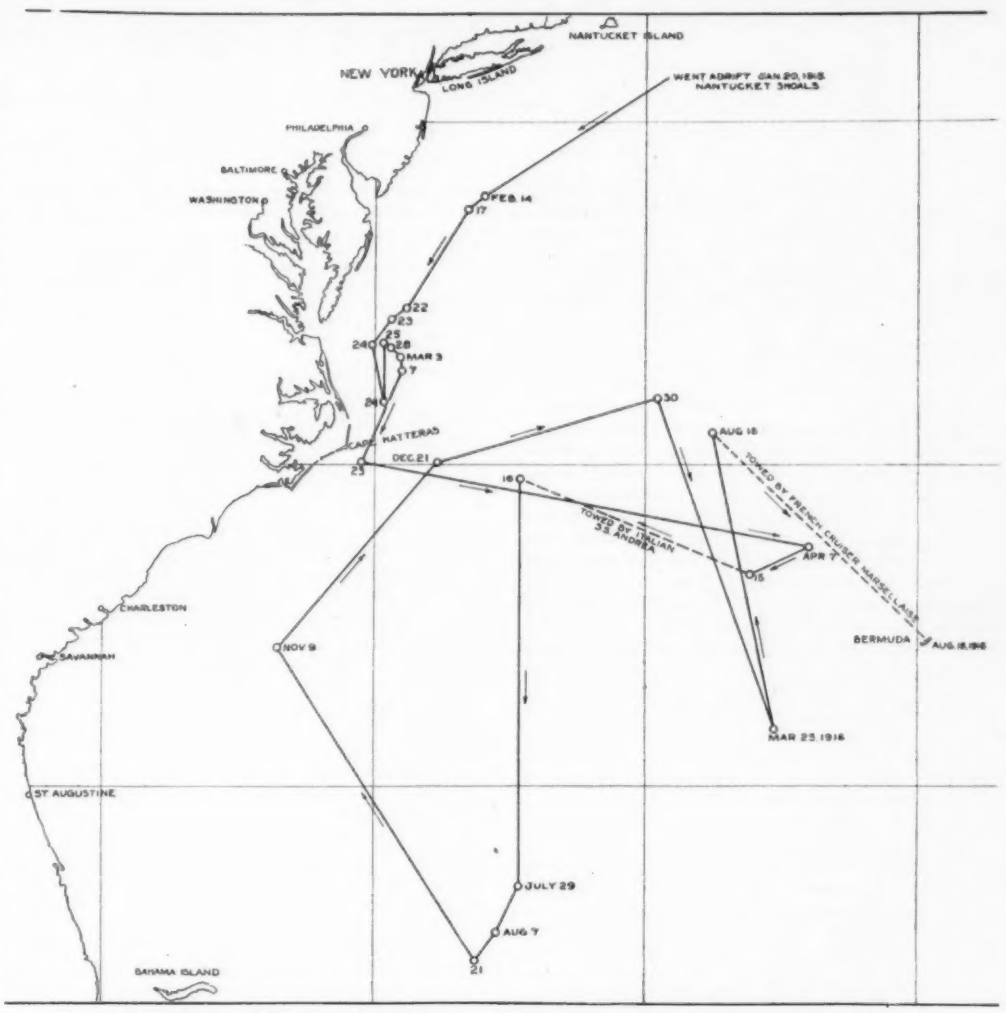


Chart showing the course followed by a drifting buoy during a period of 19 months

Where Italy is Fighting

VERY little was heard during the winter months of activities on the Italian front, but this is easily explained by topographical and climatic conditions which make large movements of troops and supplies impossible. The illustration on the first page of this issue gives an excellent idea of the sort of country in which operations have had to be carried on, and it is apparent that in the best of weather conditions field operations are most difficult; but during the winter not only are the mountains covered by a deep coating of snow, but the narrow passes, through which all traffic must flow, are so choked as to make the transportation of supplies practically impossible, even if the troops could move.

During the long winter about all that could be done was to hold the positions as they existed at the end of the open season last fall, and in preparation for this numerous observation outposts were established at every available point. Comfortable shelters that could house small detachments of men were built high up among the mountain crags where they afford a wide view of the surrounding country. Such a shelter is shown in the small accompanying illustration, while the cover picture shows how access is had to many of these observation points from which a constant watch

Shelter huts built on the precipitous face of Italian mountains, from which the enemy is constantly observed

was maintained against any threatening movement of the enemy.

Comparison has been made between the Italian campaign and Napoleon's famous passage of the Alps, but comparison fails when we consider that Napoleon's army consisted of only 2,400 men, and marched over fine, hard roads that were built by the Romans, and which had always been maintained; while the Italians are operating with hundreds of thousands of men, and to manouver these it has been necessary to build many miles of entirely new roads through otherwise inaccessible regions where hitherto no one ever attempted to go except in summer.

To sustain the troops in the snowbound regions of the high mountains hot food is an absolute necessity, and one of the interesting developments of the campaign is the introduction of big 30-gallon thermos soup kettles that enable supplies of hot food to be sent to outposts and trenches where cooking is impossible. One Italian general put the situation very clearly when he said that to conquer the enemy it has been first necessary to conquer climatic and topographical conditions that exist in the regions where the campaign is being conducted.

Removing the Taste Due to Algæ in Drinking Water

POTASSIUM permanganate, added in quantities of 2.5 to 5 pound per million gallons, has proved much more effective than hypochlorites in removing the nauseous taint due to the growth of algæ in the reservoirs under the control of the Metropolitan Water Board. The use of hypochlorites involves the risk of merely replacing one taste by another, or even of introducing a superadded taste.—Note in *Jour. Soc. Chem. Ind.*, on an article by A. C. HOUSTON in *Brit. Med. Jour.*

Search for Typhoid and Paratyphoid Baccilli in Fæces and Water

IN using the Malachite Green method for the separation of the typhoid group of bacilli from the coli group the divergent results frequently obtained are due to variations in the purity of commercial Malachite Green. The suitability of the dye can be tested by making a 1 in 3,000 solution in peptone-water; in this medium the paratyphoid B bacillus should develop and cause decolorization in twenty-four hours. In examining fæces by this method, typhoid and paratyphoid bacilli were isolated in those cases in which blood cultures were positive, and sometimes both varieties of paratyphoid bacilli were isolated when blood cultures had shown one only. The water of the river Seine, when examined by this method, was found to contain paratyphoid bacilli.—Note in *Jour. Soc. Chem. Ind.* on an article by F. DIENERT and G. MATHIEU, in *Comptes Rend.*

Initiation of Explosions*

The Various Agencies and Methods Employed for Igniting Powders

By Walter Arthur

When the historian draws aside the veil which hides from our view the dim misty past, we catch a few glimpses here and there of man's early efforts to manufacture and use gunpowder. With the scanty knowledge of the properties of various chemicals involved, and the crude methods of manufacture, many things were accomplished; and a description of them is most fascinating to anyone interested in such lines of work.

Just when gunpowder was first known is a matter of the most vague conjecture, but its use was recorded many centuries ago. Its advent into the world brought most marvelous changes into political matters, and at present, playing the most important role in the greatest of all human activity. Accompanying the use of powder and explosives, and closely allied with their development, is another and most important problem,—the initiation of the burning or explosion. Powder and explosives afford us a convenient means of doing work, if the energy represented can be made use of at a desired moment and in manner perfectly safe to those using them. Also the character of the explosion is dependent upon the efficiency of the method of ignition. Hence the importance of the question of initiation.

Until quite recent times, black powders or kindred mixtures were the only explosives in use, the energy contained was liberated by the burning of the mixture. This required only the minutest flame to start the ignition, as the particles of the various components were extremely finely divided, and only a small amount of heat was sufficient to raise them to the ignition point. The method of ignition was to fill with powder a small opening which led into the powder chamber, and by means of flame or spark, ignite this powder train from the outside. This was the old method of the match-locks and flint-locks. Most of the old cannons we see in our parks and public places were of this type.

In 1799, Howard discovered the substance we know as mercury fulminate. Its ability to fire gunpowder gave rise about the year 1815 to the development of the percussion cap. This is the beginning of what might be termed internal ignition in contradistinction to the previous method which we may style external ignition.

The percussion cap may be briefly described as a small metal capsule containing a small amount of mercury fulminate, or mercury fulminate mixture, or other mixture with similar properties. This was used by placing it over the end of a small tube which led to the powder chamber. When struck a sharp blow, the mixture detonated, giving rise to a considerable heat, thus igniting the powder. This method of ignition for firearms was in common use until very recent times and is frequently seen today. The significance of this invention was as great as the discovery of gun-cotton or smokeless powder. It made the ordinary firearms much more effective by relieving the gunner of any anxiety as to whether he had powder in his pan. It permitted of ready use and made the arm independent of the weather. The combining of the projectile, powder charge and priming charge into one cartridge, has made our breech-loading firearms and machine guns possible.

There are a number of methods of internal ignition, all of them very much alike. In some instances, as in light ammunition, where a cartridge case with a thin head can be used, the priming mixture is placed in the rim of the head. This rim being struck a sharp blow by the firing pin where it is desired to ignite the powder; hence the so-called "rim fire." In most instances the priming mixture is placed in a small cup and inserted in a chamber in the head of the cartridge case, the firing of the priming charge being done by crushing the priming mixture between the cup bottom and the anvil. Many manufacturers of such ammunition place the anvil in the cup, but others make the anvil a part of the cartridge case, the result of the explosion of the primer pellet being a flame of considerable length and intense heat. The primer cup being held securely in its chamber allows no escape of flame except through a vent into the powder charge.

The length and heat of the primer flame will determine very largely the character of explosion in the cartridge case. If the flame be short and the temperature not very high, only a portion of the powder may be burned before the projectile leaves the muzzle of the gun. This, of course, lowers the pressure behind the projectile; as a result, a lower velocity of the projectile is obtained. On the other hand, if the primer flame be long and the temperature high, all of the powder may be fired.

*A paper delivered before the American Chemical Society and published in the Proceedings of the Engineers Club of Philadelphia.

The number of mixtures proposed for use in percussion caps and primers is legion, some of which are as follows:

Per cent.		Per cent.	
21.9	sulphur (flowers).	25	lead sulpho cyanide.
30.8	antimony sulphide.	17	antimony sulphide.
47.2	potassium chlorate.	5	trinitrotoluene.
35.01	ground glass.	51.2	potassium chlorate.
28.01	mercury fulminate.	25.5	antimony sulphide.
14.00	potassium chlorate.	8.9	sulphur (flowers).
1.97	shellac.	12.4	ground glass.
21.00	antimony sulphide.	2.0	shellac.
53	potassium chlorate.		

It will be seen that either potassium chlorate or mercury fulminate is to be found in all of them. Potassium chlorate with an easily oxidizable body determines to a large extent the length of flame, sensitiveness and general effectiveness of the primer.

In order to increase the sensitiveness of the primer, an abrasive, such as ground glass, is added. The glass, due to the sharp edges and hardness of its particles, cuts into the particles of fulminate or potassium cholrate, and assists in their breaking when the mixture is crushed under the firing pin; and, as the firing of the primer is a result of the breaking of the crystals of the potassium chlorate or fulminate, the sensitiveness is thus very much increased.

The difficulties encountered in the manufacture and loading of primer mixtures are many. Owing to the extreme sensitiveness of such mixtures to friction or blows, they are usually mixed in the wet condition, and dried after loading into the caps.

In order to secure perfectly uniform results, it is necessary to have a thorough mixture of the various components. In using such materials as potassium chlorate, antimony sulphide, a great deal of difficulty is encountered in getting the proper granulation. Very coarse materials, about 100 mesh, give very poor results. The flame is short and the sensitiveness is poor. The best results come from materials of about 200 mesh. The sensitiveness and the flame length are good. The difficulty in using such fine mixtures comes in the mixing. These excessively fine materials are very difficult to mix thoroughly, owing to the tendency to collect in small pellets which resist the usual mixing. One of these very small pellets is often sufficient to cause a misfire if it gets into the primer cups.

Another difficulty, comparatively simple in its nature, yet disastrous in its results, comes from overloading the cups. Each cup is designed to hold a certain charge. Sometimes in careless filling, the maximum charge is exceeded. The anvil is forced in under great pressure, the result being that the pellet of priming material is so hard, the firing pin cannot break it; the result is a misfire.

We shall turn now to another class of explosives which require the use of a primer to liberate their energy. In the year 1864 Alfred Nobel, a Swedish engineer, used mercury fulminate for the purpose of filling priming caps to initiate the explosion of nitroglycerine and dynamite. This discovery forms one of the greatest advances of the last century—an advance to which we owe the development of the whole modern technic of explosives, and such giant accomplishments as the building of the Panama Canal. Although discovered some twenty years previous, it remained but little more than a scientific curiosity until a convenient detonator was devised. These detonators, or dynamite caps, are of two types—that which is fired by burning of a slow fuse, and that fired electrically. They consist of small copper capsules partially filled with mercury fulminate, or a mixture of mercury fulminate and potassium chlorate. The detonating cap to be fired by a slow fuse is exactly as described above; the fulminate being fired by the burning powder at the end of the fuse. The detonating caps fired electrically are as just described, except immediately above the charge of mercury fulminate is a small charge of gun cotton which is fired by the heat from a short resistance wire. The electric current necessary for such work depends upon the number of charges to be fired. These detonators are made up in various sizes and strengths, and are numbered from 1 to 10.

Designation No.	1	2	3	4	5	6	7	8	9	10
Charge in grams	.3	.4	.54	6.5	.8	1.0	1.5	2.0	2.5	3.0

By the use of electric detonators, a great many charges may be fired simultaneously, thus accomplishing what would otherwise be impossible. This method also allows all persons to retire to a safe distance before the explosion occurs. It also affords a means of detonating quantities of nitroglycerine deep down in the earth, as in oil well shooting.

Recently a great part of the mercury fulminate in these detonators has been replaced by picric acid, trinitrotoluene, or tetranitromethylaniline. The strong initial effect is thereby increased; in this way 0.5 g. of mercury fulminate has been made to detonate a charge which required 3.0. g. of mercury fulminate in the earlier caps.

The use of priming substances for high explosives in modern warfare is at present of much interest. The methods of application are much the same as in commercial explosives, the only difference being in the use of a time element in many cases. The initial primers are provided with firing pins which are actuated either by the sudden movement of the projectile in the gun or by the striking of the shell against some resisting body. Since the space in high explosive shells through which a firing pin might move is quite limited, a very sensitive priming mixture is used. Mixtures of mercury fulminate, potassium chlorate, a strong reducing agent, and often an abrasive, such as ground glass, are used. In order to protect these primers against abrasion and atmospheric agencies, shields or caps of paper or metal are provided. The whole of it must be so arranged that a light blow of the firing pin measuring only a few inch-ounces will suffice to bring about the necessary explosion of the primer. The explosion of the primer detonates a greater charge of mercury fulminate which communicates its detonating influence to the body of the main explosive. Quite often a booster charge is added between the fulminate and the explosive, and in this way the detonating action is built up.

In armor-piercing shells it is desirable that the explosion take place after the shell has penetrated the armor. In this case the action is such that the primer is fired as a result of impact of the shell against the armor plate; this in turn igniting a train of powder so arranged that the main detonating mass will be exploded at the correct moment. Owing to the fact that these shells travel at a great velocity, only the briefest delay is required between the action of the primer and the detonator.

In high explosive shells where the entire action is to be instantaneous, the delay action is omitted, the explosion of the priming charge, detonator and boosting charge taking place in most rapid succession.

In the case of shrapnel shells where an adjustable time action is required, movable trains of powder are interposed between the primer and the main charge, the primer being fired from the set-back in the gun. Shells of this type are often provided with two primers—one to be used with the time action, another one to function on impact.

There are various types of cannon primers which we can not discuss at this time; most of them differ from the small arms primers in size and mechanical details. Some of them are exploded by friction instead of a blow.

Some of the difficulties encountered in the manufacture of the various primer mixtures might be of interest at this time. The first thing that naturally attracts attention is the mixing of these compositions, as they must be sensitive to blow and friction. The handling and loading is attended with much danger. As the presence of some liquid in the mixture acts as a sort of cushion between the various particles, these mixtures are usually made up with water or alcohol. After the mixture has been put into place, the liquid is dried out. Some firms handle these mixtures dry, but it is always attended by considerable danger—even in the wet condition, the mixing must or should be done by hand. Great care must be exercised during the mixing lest some portion become too dry and the friction from the rubbing start an explosion. The mixing tables and the rooms must be kept thoroughly clean.

Attendant upon the danger from explosion is the danger from poisoning when mercury fulminate is used in the mixture or loaded separately. Not only is mercury fulminate a poison when taken internally, but the dust from it produces dermatitis and skin eruptions.

The degree of fineness in granulation of the materials is a large factor in the manufacture of primers. If the materials be very fine, difficulty is experienced in thorough mixing. If they be too coarse, the primers made therefrom are not sensitive and do not burn freely or incompletely, and give poor ignition. In the case of small arms primers, this produces low velocities due to the fact that a portion of the powder may fail to burn before it is thrown from the gun.

In the manufacture of small arms primers, it not infrequently happens that an excessive amount of the

mixture is loaded into the cup, and when the anvil is forced down, this produces a pellet so firm and resistant that the ordinary blow from a firing pin can not break it, and a misfire is the result.

It is interesting to note that the function of artillery primers made with a shallow layer of a friction mixture backed by mercury fulminate is dependent upon the character of the blow. If a light blow is delivered, the fulminate only burns; if a severe blow is delivered the fulminate is exploded. The character of the point of the firing pin has a great deal to do with the sensitiveness of primers of this type. If a blunt point be used a much heavier blow is required than if a sharp firing pin be used. If a long taper point be used much less disturbance of the mixture is produced than if a short taper point be used. A round point also gives less disturbance to the mixture than a triangular or a square point. The maximum effect should be produced by a short taper sharp square point.

The question has often arisen, "Why does a mixture of potassium chlorate and some easily oxidizable agent explode when struck a sharp blow?" This is not easily answered. The exploding depends, of course, upon the fact that crystals of potassium chlorate are broken or fractured in the presence of some substance that ignites with the oxygen very readily. If a substance, like red phosphorusf be in contact with the broken crystals, an explosion or great brisance occurs. If some substance like sulphu, which, unites with oxygen much less readily, is present, an explosion occurs which is less active and the report therefrom is much more dull. In fact, potassium chlorate and red phosphorus are so active that they can scarcely be mixed without an explosion, while potassium chlorate and sulphur will admit of quite considerable mixing. If potassium chlorate and sugar be mixed, we get merely a burning—so slow is the exchange of oxygen.

We may picture in our minds a crystal of potassium chlorate as made up of centers called potassium, chlorine and oxygen, all arranged in some perfectly definite manner and held together by lines of force of some kind. When a crystal is broken some of these lines of force between the oxygen and the other elements are severed, and for the moment are free. If phosphorus be present, which is always on the lookout for its friend oxygen, it immediately seizes upon the opportunity to add another member to its household. The warmth of friendship produces sufficient heat to warm up the neighboring oxygen communities to a state of activity, hence heat, flame and general rearrangement of affairs.

The question is asked, "What happens when a crystal is broken when no phosphorus or oxidizable substance is present?" Of course, this question cannot be answered at present; our knowledge of the molecular arrangement is too scanty. If crystals of mercury fulminate and a few other substances be broken rather quickly when unattended by an oxidizing substance, a most severe explosion occurs. But why? This is just as difficult as the other questions. The answer may be made that crystals of mercury fulminate are unstable. This explains nothing. Perhaps some of the recent work of the Braggs in crystal structure may eventually give us some information.

The question has often been asked: "What properties of mercury fulminate enable it to act as a detonator, and in what way is the primary explosion related to the principal explosion. The chief characteristic of mercury fulminate which makes it valuable as a detonating agent is the ease with which it can be exploded by simple and ordinary means and the wonderful pressure developed therefrom, which brings about the explosive decomposition of the explosive mass. A large number of chemicals are violent explosives and many exceed mercury fulminate in explosive power but are less suitable or are not suitable at all as detonators. Some are too sensitive to shock or friction; some are too insensitive. Some may cause the explosive wave in the main explosive mass to proceed too slowly. Mercury fulminate occupies the middle position. A great number of investigators have attempted to account for the initiating effect of detonating compounds. Abel advanced the theory of synchronism of molecular vibrations between the primary and secondary explosives. This theory is supported by the fact that many substances, as diazo-benzene nitrate and nitrogen chloride, could be used only in large quantities, if at all, as a detonator of explosives. While mercury fulminate in small quantities was sufficient to produce a detonation, Abel ascribed this exceptional behavior to a resonance phenomenon, which he described as a molecular vibration which brought the molecules of the explosive to be detonated into a synchronous vibration, thence to detonation. L. Wöhler made a thorough investigation of the Abel theory and came to the conclusion that it was not sufficient to account for the phenomenon. No theory advanced so far seems wholly satisfactory.

It was found by Abel that the most violent exploding compounds, nitrogen chloride and iodide, are practically without detonating action on nitroglycerine and gun cotton. Only once could he cause detonating action with 3.25 g. of nitrogen chloride, while 0.32 g. of mercury fulminate was sufficient to produce the detonating action. This remarkable difference is explained by Wöhler, by the enormous pressure which mercury fulminate shows in contrast to that of nitrogen chloride, and in addition, calls attention to the fact, although the gases evolved by the explosion of the two compounds are very nearly equal, the heats evolved are only 312 calories per kilo for nitrogen chloride as against 411 calories for mercury fulminate. Wöhler attaches the greatest significance to the fact that the loading density of mercury fulminate is far beyond that of nitrogen chloride.

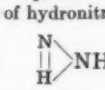
In spite of the fact that nitrogen chloride has a smaller calorie number and a lower loading density, it is likely that nitrogen chloride produces a greater instantaneous pressure than mercury fulminate. Judging from the shattering effects produced upon glass and similar bodies, nitrogen chloride greatly exceeds mercury fulminate in brisance. If we take into consideration the difference in loading density and heat evolved, we find that difference is not sufficient to account for the ten-fold difference in effect.

It is common practice to manufacture detonators which are intended for explosives that are brought to explosion with difficulty, with a booster charge of a like or similar substance, such as trinitrotoluene or tetranitro-methyl-aniline. This supports Abel's theory rather than opposes it.

In the year 1883 Bertholet offered the theory that the detonation of a brisant explosive was to be considered as a sudden wave-like decomposition, propagating through the whole mass, brought about by the kinetic energy of the detonator. According to modern views, however, neither the pressure as such, nor the violent changes brought about by it, is sufficient to account for the detonoting waves of a secondary explosive. Another author of recent date agrees with this view that it is the adiabatic heating of the medium in contact with the priming substance, caused by the great pressure which initiates the exceedingly high velocity of the detonating waves.

The action of a blow of a hammer is often explained upon the assumption that the heat, into which the energy of the hammer is transformed on being suddenly brought to rest, heats the portion of the explosive struck to a temperature at which a sudden increase of the velocity of decomposition leads to an explosive velocity. It is quite well known that very sudden heating of an explosive leads to an explosion.

How then can the detonation of an explosive be carried over an intervening air space? The thermal hypothesis will not account for this. This is explained by the compression and rarefaction of the surrounding air. Since the force of such waves decreases as the square of the distance, this theory is not sufficient. From what has been said, it can be seen to be a very complex subject, and how many theories fall when all the facts are taken into consideration.

For many years mercury fulminate has held its place as a detonating substance as superior to all others. Of recent years, however, its place has been threatened by other compounds which bid fair to displace it. One of the most promising of these is lead azide; lead azide is a salt of hydronitric acid whose constitution is expressed thus:  Some investigators unite it, thus: $N \equiv N = N - H$. This acid forms a great number of salts, as mercury azide, silver azide and sodium azide.

The heavy azides, as lead azide, are prepared by treating a solution of sodium azide with a soluble metallic salt, such as lead acetate, the sodium azide being prepared from nitrous oxide and sodium amide.

Large crystals of lead azide and mercuric azide have been found to be very sensitive to mechanical shock; the sensitiveness increasing with the size of the crystals. Even the breaking of a single large crystal is said to bring about explosion. Crystals as large as 3 mm. in length, when dry, often explode when brushed with a feather. If a hot saturated solution be allowed to slowly cool, large crystals sometimes form, which detonate under water. The formation of such crystals must be avoided. This property is scarcely obtainable with the fulminates.

Mercury fulminate and lead azide differ very greatly in flash point—lead azide flashing at about 330°, mercury fulminate flashing at about 180°.

Lead azide in fine crystals appears to be less sensitive to blow than mercury fulminate. It is very stable when stored at high temperatures, such as 50° C.; it is, however, decomposed by strong sunlight. The action of lead azide upon metals is slight, while fulminate is quite active.

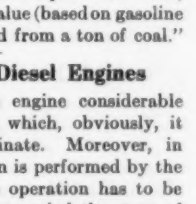
Mercury fulminate may be dead pressed, while lead azide increases its brisance and explosive power with pressure. If detonator caps be loaded with lead azide and a booster charge, much less lead azide is necessary to produce the desired detonation. The sensitiveness of fulminate to mechanical shock is much lessened by the presence of as much as 1 per cent moisture, while lead azide is much increased by this small amount. This particular property is extremely valuable in case of storage of detonating caps in humid atmosphere.

Many other substances have been proposed as detonating agents. Trinitro-resorcine or lead styphnate ($C_6H(NO_2)_2O_2Pb$) has been found to be an excellent explosive. Hexa-methyline triper-oxide-diamine ($N(CH_2O.OCH_2)_3N$) is said to exceed mercury fulminate 4 or 5 times in priming power.

A number of others may be mentioned as:

Nitrogen-tetra-sulphide, N_4S_4

Diazo-benzol-nitrate, $C_6H_4-N_2NO_3$

Basic mercury nitro-methane, 

Perchlorate of tri-mercur-aldehyde, $C_1O_4Hg(Hg_2O=_1COH$

The Recovery of Benzole

BEFORE the war the recovery of benzole was regarded with suspicion by makers of coke, apparently because they feared the market for this material would not warrant the expense, and even now this impression seems to prevail in some quarters. It is pointed out, however, in a recent article in the *Iron Age*, that not only will the demand for explosives of the benzole group be greater after the war than heretofore for military purposes, but that the showing these explosives have made in the war their use will be greatly extended in the future for commercial blasting operations. Moreover, the enormous increase in the number of motor-driven vehicles calls for corresponding increases in the supplies of fuels, and for this purpose the value of benzole is being more widely recognized as its practicability is becoming better known. Abroad it has long been an important source of power.

Besides these uses benzole is employed in the manufacture of paints, stains, varnishes and lacquers; in the cleaning industries; in the extraction of greases and fats; as solvents for rubber and the manufacture of artificial leather, and these uses are certain to increase, so that there appears to be no fear that a market will be lacking in the future for all the benzole that can be produced.

Another reason for neglecting to recover the benzole from coke ovens has been the fear of loss of calorific value of the gas produced. In regard to this the article above quoted has the following to say:

"The effect of the removal of benzol on the calorific value of the gas has been well worked out by J. W. Shaeffer, who recently published his results in an article read before the October, 1916, meeting of the American Gas Institute. The actual loss in the calorific value of the gas amounts to about 5.8 per cent, which is a figure representing the average practice of about 30 by-product coke plants. The figure agrees well with theoretical considerations. The result is that more debenzolized gas has to be used for accomplishing a given heating effect. Assuming that one ton of coal makes 11,000 cu. ft. of gas, a reduction of 5.8 per cent is equivalent to 638 cu. ft. less gas. As boiler fuel this gas is worth about 6 cents per 1,000 cu. ft., so that the reduction may be figured to cost about 3.83 cents per ton of coal, *i.e.*, about 8 per cent of the normal value (based on gasoline prices) of the total benzol recovered from a ton of coal."

Reversing Propellers for Diesel Engines

FOR reversing a Diesel marine engine considerable additional mechanism is required, which, obviously, it would be an advantage to eliminate. Moreover, in many of these engines the operation is performed by the use of compressed air; and if the operation has to be repeated many times within a short period the store of air may be exhausted at a critical moment. Moreover, the operation puts severe strains on the engine. To get around these difficulties a large foreign builder of this class of machinery has revived the reversible propeller for large ships. For small craft this kind of a propeller has been found quite successful, but on a large scale it has not worked out so satisfactorily. It is claimed that this is because of improper design, and a wheel of this construction has worked well with a slow speed engine of 500-horse-power. Another advantage of this kind of a propeller is that it enables the navigator on the bridge to have complete control of the ship's movements.

Blown sand—Erosion on seaward side of coastal dune

Mass of advancing sand—Wind ripples indicate the direction of advance

Still living tops of buried trees, marking the advance of sand

Landward advance of sand gradually overwhelming a fir forest

Sand Devastation

How the Dunes Advance and How Their Movement Is Checked

By Percy Collins

It is estimated that nine tenths of the coasts of the world are fringed with sand. Where has this come from and how has it been formed? If we examine a sample of sand from the seashore we shall find that it consists for the most part of quartz grains, and that these are singularly uniform in size. It is really so much rock triturated by the action of the waves.

While the nature of sand is thus easy to define geologists are admittedly perplexed to account for its abundance. The erosive action of the sea upon rockbound coasts, aided by land springs and atmospheric weathering, has doubtless contributed largely to the formation of sand; but in the opinion of experts this cause is not, in itself, sufficient to account for the vast accumulations which are known to exist. Probably a very large percentage of the sand that is piled to-day along the coastlines of the world represents the *débris* which was carried to the ocean by torrents and glaciers of the ice age.

The distribution of sand is governed, in the first instance, by the set of the ocean currents and the character of the shore. Where the coast is flat and unprotected by cliffs enormous quantities of sand are often cast up by the waves upon the beach whence, as the tide recedes, the particles are carried inland by the wind. Each grain, being unattached, is free to be moved by every gust that blows; but the progress of such grains as may be carried to leeward of any solid object, such as a stone, a frond of seaweed, or a living plant, is likely to be arrested. In this way little mounds are formed.

Those who have wandered on the shore, especially after a high wind, cannot fail to have observed these "sand-streamers," as they are called, collected under the lee of arresting objects. While it is easy to realize that when these arresting objects are living plants, which grow upward as the sand collects about them, an actual building up of a permanent heap may result in process of time. Certain maritime plants and grasses with spreading fibrous roots subserve a useful purpose in thus arresting and binding together the loose sand on the seashore.

It is, then, the presence of certain sand-loving plants on the shore above highwater mark which provides, in the first instance, sheltered spots for the accumulation of wind-driven sand; and this is the principle which underlies the origin of all permanent sand formations on the coast.

Strange as it may seem, there is now no room for doubt that to the combined action of the wind and arresting vegetation are due the enormous hillocks and ridges of sand, called dunes, which are so characteristic of many coastlines. Sand dunes are known technically as "gray" or stationary, and "white ' or shifting, according to their condition. When the sand cast upon the shore by the waves is not excessive, and when the wind is intermittent, plants of many kinds are able to take root and flourish between the tufts of hardy growths which were the original sand arresters. These gradually cover the surface, while their roots bind together the particles of sand. Thus the gray or stationary dune is formed—a ridge of sand, clothed with vegetation, running parallel with the shore.

Such dunes often form a kind of natural embankment and protect the low ground inland from the inroads of the sea. The low-lying ground, once a brackish marsh, may be slowly raised by the growth and decay of aquatic plants until, with the passage of years, mankind is able to drain and cultivate the soil. Moreover, as the sand-loving plants tend to edge seaward there can be no doubt that parts of the foreshore itself are occasionally reclaimed.

With the white or shifting dunes the case is different. These do not differ from the gray dunes in their origin; but owing to the vast quantity of sand brought in by the tides, and the force and prevalence of the wind, there is a constant drift of sand particles. Thus the sand-building plants are unable to take root; and as the dune is held together only by the relatively lax growths of the bent and other hardy grasses which were the original dune builders, the surface is constantly broken by the wind, while the sand removed from the windward side flows over the ridge and is caught by the vegetation to leeward.

In this way the whole dune may move inland, traveling by degrees with the prevailing wind. On the low shores of the Bay of Biscay the annual advance of the dunes may be as much as sixteen feet, and they have at times overwhelmed extensive areas of cultivated land, both in this district and in other parts of the world. Sometimes the advance of the sand is appallingly rapid owing to special meteorological conditions.

A very striking instance of devastation due to wind-driven sand has recently been investigated by experts. The districts in question are those of Culbin and Mavis-ton, on the coasts of Elginshire, Scotland; and the following account from the pen of Prof. F. O. Bower conveys an accurate impression of this sand-harried area:

"The estate of Culbin, extending to some 3,600 acres, was in the seventeenth century celebrated for its fertility. It was intersected by the river Findhorn and included, besides smaller holdings, some sixteen farms. The disaster which buried the whole estate beneath the sands came suddenly in the autumn of 1694. The sea had been encroaching extensively on the land farther to the westward, so that a large expanse of sand was exposed at low water. It is stated that a westerly gale carried immense quantities of this sand over the fertile land, covering fields and houses, burying the mansion-house itself, and even diverting the course of the Findhorn River. Ever since the Culbin sands have been a vast shifting area. If marram grass obtains a hold here and there, and dune-formation proceeds, it is again torn out by the winds. A large part of the area remains as bare sand-hills, without a trace of vegetation upon it. Here the surface sand is free to move with every wind and the form is constantly changing. The effect of this is well shown at a point where a wood of Scotch firs has grown to maturity. The sand advancing in a wreath some 40 feet high is gradually enveloping the trees. Elsewhere the sandy

Culbin sand hills—On the left is shown old land surface with ridges and furrows of former cultivation

Forest at Maviston, first buried and then uncovered by drifting sand as the dunes move forward

Advance of drifting sand upon an arresting fir forest in Maviston—In the foreground, planted Bent grass to retard advance

Blown sand bound together by Bent grass forming dunes—The bays are the result of inroads of sea during storm

Arrest of drifting sand by Bent tufts

Sand dunes planted with Bent tufts to arrest drift

Sand dunes covered with heavy growth of vegetation

Sea holly—one of the prettiest of sand loving plants

pall is being removed again, and the dead stumps are all that remain to show the destruction that has been wrought."

By the courtesy of the Geological Survey of Scotland the present writer is able to reproduce photographs of the Culbin and Maviston sand-hills. These bear striking testimony to the devastation caused by drifting sand. In one picture is seen how the advancing dune has passed, laying bare the old land surface with the ridges and furrows of former cultivation. The efforts which are being made to arrest the flow of sand by means of marram grass and fir plantations are also well illustrated.

This is only one instance among many that might be cited. The complete obliteration of woods may be seen on even a larger scale elsewhere, for example, on the shores of Lake Michigan and along the eastern coast of Virginia. Fortunately, the wits of man have devised a plan which, when put into force, rarely fails to check the devasting flow.

It is said that a method of fighting the sand was suggested by a priest of Mimizon. Be this as it may, there can be no doubt that the methods now employed were first outlined by M. Bremontier, an eminent French engineer, in the year 1780. The practical value of his theories, which were adopted by the government of the time, was soon established.

Bremontier's knowledge of botany enabled him to make use of sand-loving plants—the vegetable coast-guards—to which reference has already been made; and profiting by observation, he devised means whereby the formation of a gray or stationary dune would be assured. Briefly his method was this: He erected a continuous wooden paling, some four feet high, parallel with the foreshore and about one hundred yards back from high water mark. A space one inch wide was left between the boards.

Now it is a peculiarity of wind-blown sand that it does not rise like dust, but flows forward in a manner suggestive of water. Thus, it became piled up against Bremontier's palings, while much of it, passing through the crevices, was deposited to leeward. This went on until the boards were buried, when they were raised one at a time. By continuing this process, the dune was made to rise steadily in height, assuming a slope of from seven to twelve degrees in front, and much less on the land side.

On first setting his fence Bremontier planted tufts of marram grass before it in a belt eight times wider than the obstacle opposed. These tufts he set close together beneath the palings in quincunx order—*i. e.*, in sets of five tufts, disposed in a square, with one tuft at each corner and one in the middle. In this manner an even slope of the desired angle was secured and maintained. The marram tufts were set in winter, and among them were sown seeds of the same and other grasses. These grasses grew upward as they were buried, binding together the particles of sand in a network of roots.

Subsequently the surface of the newly formed dune was sown broadcast with a mixture of the seeds of sand-loving plants; and these, springing up, eventually bound together the whole mass of sand with their roots. Behind the stationary dune thus formed fir plantations were set; and in this way an impervious barrier against the further encroachments of wind-driven sand was secured.

To the success of Bremontier's plan, as adopted on the French coast, Mr. G. B. Emerson, an American savant, bears eloquent testimony: "In 1872 I visited the region saved by Bremontier and examined the work he had done, and its effects. The whole country, for more than a hundred miles along the Atlantic coast of Gascony and from four to eighteen miles landward, had been covered with sand hills. . . . The process of ruin had been going on for centuries, and some of the sand hills were hundreds of feet high. In the midst of this recovered region I stopped a day or two at a beautiful town, where a hundred thousand persons from Paris and other cities of France, attracted by the genial climate and health-giving atmosphere of the pine forests, had passed the winter. I walked and drove along the sandy roads, visited a monument to Bremontier, erected by his brother ten miles or more inland in the redeemed territory, and saw in many places deciduous trees—oaks, ashes, beeches and others—growing luxuriously under the protection of the pines."

The dunes on the coast of Holland and Denmark have received systematic care for centuries past. Maritime grasses and creeping plants are sedulously encouraged, while burrowing and grazing animals are rigidly excluded. France, as we have seen, has accomplished wonders, while similar means for resisting the encroachments of shifting sand were long ago adopted on an extensive scale by the United States.

In conclusion, it may be said that the sand grains of the seashore differ in character from those of the great inland deserts. Microscopic examination reveals the fact that whereas the former are always more or less angular, the latter are relatively smooth and rounded. The explanation of this is that the grains of sea sand, being normally wet, are kept from close contact with each other by the water film which surrounds them. The grains of dry desert sand, on the contrary, continually rub one against another as they are blown about by the wind, and are eventually converted into fine dust. In deserts, the sand dunes are raised by the action of the wind alone.

Chemical Composition Versus Electrical Conductivity*

By Collin G. Fink

Some years ago, while still at the university, I carried out a number of experiments on the electrothermic production of ultramarine. Powdered mixtures of sodium sulfide, china clay and carbon were interposed between carbon electrodes in a closed crucible furnace. I observed at the time that in order to keep the electrical resistance and the temperature of the charge fairly low so as to avoid decomposition of the ultramarine as soon as it was formed, it was necessary to use very finely divided carbon, such as lampblack. With charges made up of powdered coke which was coarse compared to the lampblack, I could not get any appreciable current to pass between the carbon electrodes up to potentials of 250 volts.

Subsequently, I have found repeatedly that the electrical conductivity of mixtures of finely divided substances is a function of the relative size of the components.

A series of tests was made in order to get values of a more quantitative nature. Two substances were selected, the physical properties of the one as divergent as possible from those of the other: a black metal powder, tungsten, and a white insulator powder, thoria. The advantages in this selection are manifold; both tungsten and thoria will stand very high temperatures and can therefore be made practically moisture-proof.

It is a well known fact that in all high-resistance tests adsorbed moisture is a very disturbing factor. Metals such as copper and silver were not serviceable since they cannot be heated to high temperatures without partial vaporization, which though slight was sufficient to cover the surface of the insulator granules with a highly conductive film. Other factors that decided our selection in favor of tungsten and thoria were: (1) high state of purity; (2) availability of both in extremely fine powdered form (readily sifted through 250 mesh gauze); (3) constancy and stability under ordinary atmospheric conditions; (4) sharp distinction in color; (5) high specific gravities (which reduced the tendency to dust).

All mixtures here recorded were made up of equal weights of tungsten and thoria. As regards the size of the particles, as stated above, the mixtures would pass readily through silk having 250 meshes to the inch. The holes in this silk are about 0.001 inch in diameter. All attempts to segregate particles of a well-defined size by such methods as suspending in water, organic liquids or air, were frustrated on account of the persistent tendency of the very fine particles to form agglomerates.

We finally resorted to the familiar "tap test." This gave us fairly good comparative values of the fineness of the various powders used. Ten grams of the powder or powder mixture were filled into a 10 cc. glass graduate and tapped to constant volume; usually, after seven minutes no further decrease in volume could be detected.

The ultimate volume in cc. divided by 10 gave us the relative volume (v_r) as recorded in Table I. It can easily be demonstrated that the values for v_r are a function of the density and mean particle size. At first there seemed to be a serious objection to the tap test, namely this, that a powder composed of, say, equal parts of coarse and fine particles would give the same value for v_r as a second powder whose particle size was a mean between the two limiting sizes of the first powder.

This objection to the tap test was automatically set aside since in the ordinary preparation of metal or oxide powders in a single small lots by far the greater majority of particles are approximately of the same size. This tendency to form a "standard" size is a universal phenomenon, the dimensions of any particular standard being dependent upon the physical conditions such as temperature, strength of solution, etc., under which the particular powder is prepared. (Compare also, the uniform size of the crystals of granulated sugar as regulated by the strike pan).

Table I

	Relative Volume (v_r) of				
			Mixture		
Mixture	ThO_2	W	Found	Calc.	Appearance of Mixture
R....	0.720	0.113	0.430	0.417	White
P....	0.720	0.350	0.565	0.535	White
Z....	0.576	0.235	0.389	0.406	White
T....	0.305	0.113	0.200	0.209	White
S....	0.305	0.330	0.275	0.318	Black
X....	0.238	0.577	0.420	0.408	Black

Referring to Table I, we note that the thoria powders varied in relative fineness between 0.720 and 0.238 and the tungsten powders between 0.577 and 0.113 cu. cm. per gram. The calculated value for v_r of any mixture is equal to one-half the sum of the v^r values of the ThO_2 and W constituents. These calculated values agree fairly well with the experimental and support our contention that the particles of any freshly prepared powder are of fairly uniform size. If this were not the case no such agreement between the calculated and experimental values would be possible.

As to the appearance of the mixture, if the v_r value for the white powder is high as compared with the value for the black powder, the appearance of the mixture is white; if the white powder is coarser than the black powder, the appearance of the mixture is black. In other words, whenever the ratio of v_r for ThO_2 to v^r for W is greater than 2, the mixture is white; if less than 2, the mixture is black. [The absolute density of W (19.6) divided by the absolute density of ThO_2 (9.8) = 2.]

Electrical Measurements

The powders were pressed into rods 4 cm. long and 0.5 cm. square. They were then placed in a tungsten-hydrogen furnace and fired at 1600–1650° for three hours. This firing caused the rods to sinter together and rendered them practically proof against moisture. The fired rods were kept in a P_2O_5 desiccator. The rods were then mounted between brass clamps and the resistance measured on a Wheatstone bridge with a sensitive galvanometer. Care was taken to make these measurements on days when the humidity of the air was low.[1]

In view of the differences in "color" of the various mixtures in the powdered form, it was not very surprising to find marked differences in the electrical resistances although the firing at 1,600° resulted in an almost uniform shade for all of the mixtures. In Table II below are recorded four of the characteristic resistance values found. In the last column are the calculated specific resistance values.

Table II

Powder ThO_2 No. 2	Resistance	Resistivity
	Over 10^{13} Ohms	Over 10^{13} Ohms
Z	41.8	173.0
X	0.2071	0.108
W No. 1	0.0040	0.016

The powders, ThO_2 No. 2 and W No. 1, were pressed up into rods the same size as those for the mixtures; they were likewise fired at 1,600° for three hours.

Since in all of our original powders a small percentage of grains was present whose size was considerably smaller than that of the majority of the grains, the results tend to show that under ideal conditions of mixture, relative grain size, uniform distribution, etc., the resistivity values for white mixtures such as Z would be even higher than here recorded. Similarly, the resistivity values for black mixtures such as X would be even lower than those found, approaching a limiting value equal to twice that of the 100 per cent metal rod.

In general we may conclude that the electrical conductivity of a substance is primarily dependent upon the shape and the distribution of the fundamental grains or particles composing the substance; and secondly, upon the presence or absence of thin films of secondary material enveloping these ultimate grains.

On the basis of this theory we can account for the comparatively high conductivity of gels that contain but a trace of conducting material. We can also account for the marked difference in resistance of say two samples of commercial copper, whose chemical composition is identical, depending upon whether the impurity, such as sulphur, is uniformly dissolved in the metal or whether it forms a film ("cement") of copper sulfide around pure granules of copper. The latter case is to be regarded, as Bancroft suggested, as an emulsification of copper in copper sulfide. The high resistance of these surface films composed of say sulfide or oxide or arsenide accounts for the high resistivity values of copper containing but a trace of one or more of these impurities.

*Presented at the 53d Meeting of the American Chemical Society, New York City.

[1] Compare in this connection H. L. Curtis, "Surface Leakage over Insulators," *Phys. Rev.*, 3, 490.

Astronomical Drawings*

Practical Suggestions for Recording Observations

By William Porthouse

THE value of astronomical observations is frequently enhanced if they are accompanied by a drawing or drawings of the phenomenon in question, no matter how elementary the observation or how imperfect one's command of the pencil, therefore the amateur observer should endeavor to illustrate his written observations whenever they lend themselves to such treatment. It is not every observer, however, who knows how to set about the work in the first instance, so that the following epitome of the methods which, generally speaking, I use myself, may be acceptable. It is not implied that these methods are necessarily the best. They have had to be worked out by a system of trial and error, without any art training at all, therefore I am quite prepared to believe that shortcomings exist. The sole idea should be to devise ways and means of recording one's observations so that the result is a pictorial representation which shall be as faithful to nature as is consistent with one's abilities, and capable of conveying a reasonable idea of the phenomenon under examination to a person of average intelligence.

It is not suggested that it is possible to make a finished drawing at the telescope. All my drawings are finished indoors, as are, I imagine, the majority of astronomical drawings. A rough sketch is made at the instrument, and only the material on that sketch is utilized in making the finished drawing. This is not an ideal state of affairs, of course, but so long as the observer is absolutely sincere in his resolve to keep rigidly to what he has actually observed and recorded on his rough sketch there can be no reason in striving for an unattainable ideal.

As regards medium, the stump and crayon method has been found the quickest and most satisfactory in the long run, owing, primarily, to the ease with which erasures may be made. The crayons are known in the trade as "chalk pencils." They are sharpened to a coarse point, which is rubbed on fine glass-paper. The dry color is then taken up from the glass-paper by the stump, which is merely a piece of absorbent paper rolled up and drawn out to a point. The lead in an ordinary lead pencil can be used in the same way, but erasure is not so easy, and the result has not the deep warm velvety blackness of the chalk pencil. Moreover, the surface is much more delicate and liable to be rubbed. Gradation of tone with the chalk medium is readily obtained. Light spots can be taken out of darker areas by means of a pointed rubber. The paper used is in most cases an unglazed drawing paper, having a surface with a minimum of grain, but still rough enough to ensure a satisfactory "bite" on the part of the stump. The chalk pencil is seldom applied to the paper direct, that is, without the use of the stump.

In drawing sunspots the umbra should be outlined first, and the shape of the penumbra sketched in. The detail of the penumbra should follow. Before the umbra is blocked in, the disposition of any bridges should be noted, as it will probably be necessary to leave these blank on the drawing in order to attain the vivid effect of contrast which they always make with the umbra itself. It is desirable to introduce the granulation of the solar surface, taking care that the result is merely a faint suggestion or impression of a granulation, and not a well-defined and heavily contrasted sprinkling. No one can be expected to give an exact representation of what is observed. Conventional methods, therefore, have to be adopted, and such methods, with care and common sense, furnish us with quite reasonable results. An old stump is used for the purpose, and it should be rubbed down on a piece of rough paper, rolling the pointed end during the process, until it has reached such a state as regards freedom from color, that there is little chance of anything too pronounced being left on the drawing. Faculæ are introduced negatively, as it were, by taking out the granulated surface to the required extent with the pointed rubber, by which means a very soft and tenuous edge can be obtained. Prominences, being seen a vivid red in the spectroscope, are most effective when drawn with red pencil on black paper.

Mercury and Venus may be readily drawn by means of a compass. The area of the illuminated portion of the disc is given for every few days in the *Nautical Almanac*, with the position of the terminator, so that one can prepare beforehand a rough diagram of the observed planet, which, when taken to the telescope, will probably only require amendment at the cusps if the planet be horned. In this way no time is wasted in making eye estimates of the actual phase. Drawings of the inner planets are best made in monochrome: dark markings on a white disc. Any suggestions of color received at the telescope are so faint as to be beyond representing without great danger of exaggeration.

Mars at opposition may be drawn by compass, but when near quadrature the pronounced phase will require to be shown. The exact amount of phase is indicated for every other day in the Ephemerides for the Physical Observation of Mars in the *Nautical Almanac*. The best results are obtained by laying on the disc a thin wash of ochre or orange, leaving white patches at the proper points to represent the polar caps. The dark markings are then introduced with the stump, unless their color is sufficiently pronounced to justify tinting them on the drawing. Their color is said to be greenish-grey.

In the drawing of planetary details generally, there seems to be a rule that the general intensity of the markings may be increased ad libitum so long as the relative intensities are undisturbed. Although I follow this rule myself I am willing to confess that it is open to criticism. It would be better if the observed intensities could be rigidly reproduced, without emphasis or exaggeration, even although there may be no intentional deception in the method now practised.

The shape of Jupiter is that of an oblate spheroid, the Poplar diameter being one-sixteenth less than the Equatorial. The disc of the planet may be drawn by describing a circle with the compasses, afterwards either cutting down the Polar diameter or increasing the Equatorial to the proper extent. The apparent shape of the disc is practically constant, and therefore it is desirable to cut out of thin card a disc exhibiting the correct amount of oblateness. The edges of this card are rubbed down to a fine and regular curve on glass paper, and the template thus provided will serve to guide the pencil when outlining drawings. The scale of the Jupiter Section of the British Astronomical Association should be adopted, viz., 2½ inches major axis, this being ample for the proper and effective display of all details which are usually observed on the planet.

Personally, I always draw the belts of Jupiter in monochrome, although the colors are sometimes very well defined. The shadows of the satellites are introduced with the chalk pencil itself sharpened to a fine point. A satellite in transit cannot be represented very satisfactorily, unless it happens to travel along one of the darkest belts. The introduction of the satellite by the use of Chinese white is not to be considered at all. A picture of Jupiter is always greatly improved if one or more satellites are sufficiently near to be included in the drawing. Great care must be taken that the satellites are not drawn too large in comparison with their principal: if they are not observed as discs they should not be drawn as such.

Saturn is undoubtedly the most difficult of the planets to represent on paper. It is quite a full evening's work to plot the series of ellipses of which the picture is comprised. These are six in all, viz:—

1. Outer edge of outer ring.
2. Inner edge of outer ring.
3. Outer edge of inner ring.
4. Inner edge of inner ring (or outer edge of crape ring; these rings usually merging into one another).
5. Inner edge of crape ring.
6. Limb of the globe.

In the *Nautical Almanac* is found a page of elements for determining the magnitude and appearance of Saturn's rings for every ten days throughout the year. From these the respective axes minor and major of the six ellipses can be readily calculated and reduced to terms of inches. The resulting measurements are then set out on the drawing paper, and the ellipses are drawn by the simple but perfectly effective thread-and-pin method. Another column in the *Nautical Almanac* gives the inclination of the minor axis of the ring system to the circle of declination, and enables us to pose the planet on the drawing in its proper relation to our meridian. The shadow of the globe on the ring, and of the ring on the globe, are inserted with the pointed pencil itself, and it will sometimes be found necessary to use the pencil in order to obtain sufficient density of the crape ring, which is usually drawn far too bright.

In drawing planets generally, the disc is always surrounded by a background of deep black, the result of which is a considerable improvement in appearance. The production of this black background is far from easy, as it entails two, and sometimes three, coats of Chinese ink before an intense black of even density is obtained.

Occasionally one wishes to plot a field of stars. It does not seem to have struck observers that the most effective way to do this would be to use white ink or pencil on black paper. The colors of the stars are primarily five in number—white, blue, red, yellow, and green, and pencils of these colors are readily obtainable of very fine quality, and are much more effective on black paper than on white. Comets, meteors, and kindred objects are also best represented on black paper. Occasionally the more striking meteoritic phenomena are accompanied by exhibitions of color, and if one is fortunate enough to witness a good display of this nature, black paper and colored pencils provide the best method of recording it permanently.

The drawing of lunar formations is probably the most difficult astronomical work an amateur can undertake. To make it as easy as possible a skeleton outline of the formation under examination is taken to the telescope, and the observed detail carefully filled in as rapidly as possible. Outline maps merely show the shape of the formation and the disposition and chief characteristics of the neighboring objects, and may be the result of earlier observation, or be made much more accurately from enlarged lunar photographs.

When commencing the finished drawing, the outline of the formation is first either copied freehand or transferred by means of carbon paper. The disposition of the heavy shadows is then traced in, and the shadows blocked in immediately with the stump and heaviest chalk pencil. The pointed pencil itself should not be used for this purpose, as it provides too black a shadow in comparison with the remaining portions of the drawing. Chinese or Indian ink should never be used for the introduction of the shadows either on the Moon or the planets: it should be reserved entirely for the background of the sky, where its great density serves to throw into prominence the picture of the object it surrounds.

After the heavy shadows, the next darkest details are added, and the highest lights left to the last. By taking the details in this order a proper relation between the varying intensities of the picture is maintained. If the high lights are put in first, it may be found at the finish that one cannot get the dark shadow sufficiently black relatively to the other features. It is axiomatic that there should be no areas of untinted paper on the finished drawing, even the highest lights receiving a perceptible amount of color.

One of the most important points in the production of astronomical drawings is size. From the experience of many years I say, without hesitation: "Make them on a big scale, and you will be surprised how fine they look when photographed down." Faults of draughtsmanship and irregularities of curve which would be very noticeable on a small drawing, are relatively smaller on a big picture, and often pass unnoticed.

Few drawings of celestial phenomena, save that of the planet Saturn, convey much to one unless they are accompanied by certain particulars. On every drawing should appear information regarding date, hour, conditions of observation, definition, etc., size and type of telescope used, and magnification employed. On drawings of Mars and Jupiter the longitude of the central meridian should be stated, for both systems in the case of Jupiter. In the case of the Moon, the longitude of the terminator, the age of the Moon, and if possible, the elevation of the Sun above the object delineated, should be given. With these particulars the drawing will always be intelligible to those who are interested in astronomical science.

*From the *Journal* of the Manchester Astronomical Society.

Emulsions and Suspensions with Molten Metals

FROM a consideration of numerous cases in practice where emulsions or suspensions of molten metals or alloys with solids, liquids, or gases are produced unavoidably, as in the refining of aluminium chips, "floured" or "sickened" mercury, dirty molten sodium, and "blue" zinc powder, or intentionally as in sherardizing and in the production of the lead-copper mixture used for packings, bearings, etc., it is suggested that, if procurable, many stable emulsions of metals normally immiscible in the liquid state might prove of use industrially. Although useful emulsions of gases with metals are rare, it is known that lead made porous by an indirect method is much more efficient than solid lead plate for storage batteries; and it is probable that other metals, if rendered uniformly porous by emulsification with gas while in the liquid state, would find many industrial applications. Investigation of the colloid chemistry of molten metals and alloys would doubtless yield much valuable information.—*Note from the Journal Society of Chemical Industry on a paper by* H. W. GILLETT *in J. Phys. Chem.*

A One-Quarter Horse-Power Single-Phase Induction Motor—II

Complete Details and Instructions for Building

By Charles F. Fraasa, Jr.

Concluded from Scientific American Supplement No. 2156, Page 270, April 28, 1917

The castings are to be cleaned with an emery wheel, or a file and emery cloth. All rough surfaces on the outside of the castings are to be ground smooth. The base lugs or feet should be ground to shape. Then bore out the bearings to ⅞ inch for the bearing bushings. Mount the bearing endplates on a mandrel and face the bearing hubs. Then finish the surfaces of the bosses and turn the recess (A) Fig. 14 on the inside of the endplate to 6⅝ inches in diameter and ⅛ inch deep. Fig. 14 gives the finished dimensions of the endplate. The

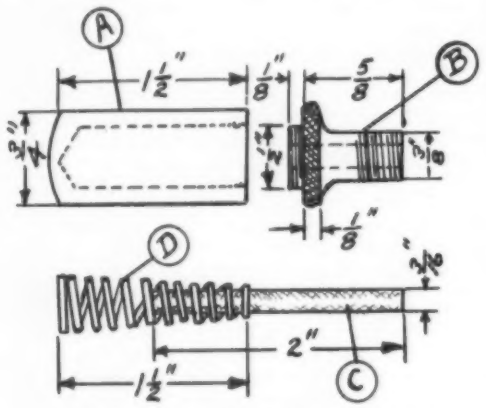


Fig. 15—Dimensions of grease cup parts

bosses (A) should have 5/16-inch holes drilled in them for the rods which bolt the endplates to the stator. The hole (C) for the grease cup should be drilled and tapped with a ⅜-inch tap.

The bearing bushing is made of hard brass or phosphor bronze 1⅛ inches long. The inside should be accurately bored to a diameter of 9/16 inch. Then mount the bushing on a mandrel and turn the outside to ⅞ inches in diameter. The bushing should be forced in the endplate and should be a driving fit. When the bushing has been driven in place ream with a 9/16-inch reamer.

The grease cup, Fig. 15 is composed of a brass tube (A) 1½ inches long, bored out to a diameter of ½ inch. The end is threaded for a distance of 3/16 inch. The cap (B) is turned from brass and threaded to screw into the tube (A) as one end, and into the bearing on the other end. A 3/16-inch hole is drilled through it as indicated by the dotted lines. The grease is fed to the bearing by the wick (C), which has a piece of brass spring wire coil about it as shown at (D) to force it against the shaft. The wick passes through a 3/16-inch hole in the bearing bushing.

The rotor is constructed of No. 27 sheet steel, enough sheets being used to make a stack 2⅝ inches thick when tightly compressed. These sheets may be cut on tinner's squaring shears, 4¼ inches square, but the turning will be somewhat facilitated if they are roughly cut to a diameter of 4¼ inches. Shellac or japan one side of each disk, clamp the stack of sheets together with two pieces of 1/16 inch or one piece of ⅛-inch sheet copper 4¼ inches in diameter, and drill a ¾-inch hole through the center. Then center an 8⅜-inch piece of 1-inch steel rod for the shaft Fig. 16 and turn down the center portion (A) 3⅞ inches long to ¾ inch in diameter, and the ends (B) and (C), to ⅝ inch in diameter. Thread both ends of the central portion for a distance of ¾ inch. These ends are then threaded for standard ¾-inch hexagon nuts, two of which should be provided. The rotor disks are then put on the steel shaft with the copper on both ends and the hexagon nuts are turned on, clamping the disks tightly together. Mount the whole in the lathe again and inscribe a 3½-inch circle on one of the copper disks with the tool. Remove from the lathe and divide the circumference of this circle into 35 equal parts, centerpunching to locate each slot for the rotor bars. Thirty-five 7/32-inch holes, Fig. 17, are then drilled at the points center punched, clear through the core. For the bars, 35 pieces of No. 4 bare copper wire, cut to a length of 3 inches will be required. The bars may be inserted bare, but it is best to wrap a thin strip of bond paper around each bar before inserting in the core. The paper may be secured to the bar by means of shellac. The insulating should be trimmed off the ends of the rod, leaving only the center insulated for a distance of 2⅝ inches. Scrape the ends clean so that the bars will make good contact with the copper disks which short circuit them.

The bars are then inserted and rivetted down on the ends. When the bars are rivetted, mount the rotor in the lathe and turn down the outside to 3 47/64 inches in diameter. This will leave an air-gap of about eight- or ten-thousandths of an inch around the rotor when the machine is assembled. It is well to work slowly, with a low cutting speed and a fine cut, because the shaft is so small that the machining is liable to spring it out of true.

When the rotor has been turned down to size, turn down the shaft ends of 9/16-inch in diameter. This was reserved until this point because the shaft will spring somewhat when machining the core.

To insure the best contact, the bars must be soldered to the copper end rings. A large blunt ended soldering iron is used with a flux that will make the solder flow freely. The solder should be flooded over the copper bars and end rings. When both ends are soldered, mount the rotor between lathe centers and turn off the solder on the faces of the ends down to the copper rings. The slots in which the bars are placed should be opened by a saw cut, two blades being fastened in the hacksaw frame to give a suitable width of cut. Provide four vanes or fans for each end of the rotor. These fans, dimensioned in Fig. 17 are secured to the end rings by means of small machine screws in holes tapped for that purpose. It is not necessary to provide these fans, but the machine will run cooler if they are used. The assembled rotor will then appear as in Fig. 18. For the shaft dimensions refer to Fig. 16. When the rotor is complete it should be carefully balanced.

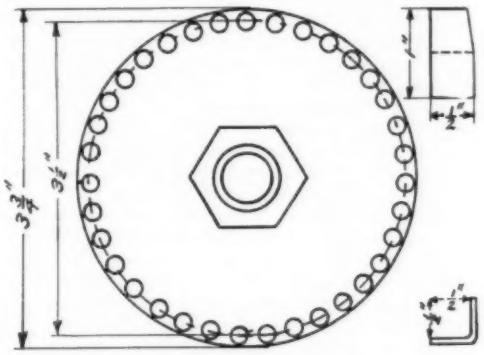


Fig. 17—End view of rotor

The phase coils are wound exactly in the same way except that the coil starts in slots (3-3), continues in slots (2-2), finally expanding into slots (1-1). The phase coil consists of 60 turns of No. 26 s.c.c. magnet wire divided into three parts. The two inner coils consist of 24 turns each per pole and the outer coil of 12 turns each. The connection of the phase coils is the same as for the main coils.

All connections between coils should be soldered, using a non-corrosive soldering flux, and well taped. The two terminals of each set of coils should have a piece of flexible lamp-cord soldered to it for connection leads.

The motor is made automatically self-starting by means of the simple device, Fig. 20, which cuts the phase coils out of circuit when the motor is nearly up to speed. The motor is started by simply closing the main switch. The phase cut-out is composed of two brass contactors

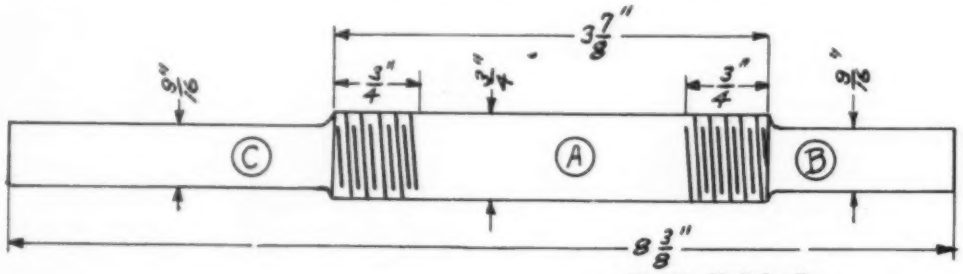
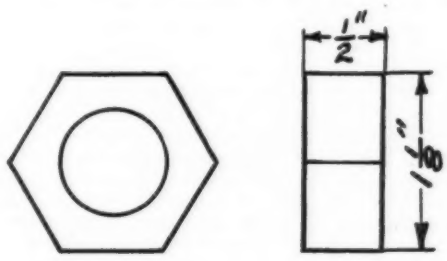


Fig. 16—Shaft details



PART III—WINDING THE STATOR

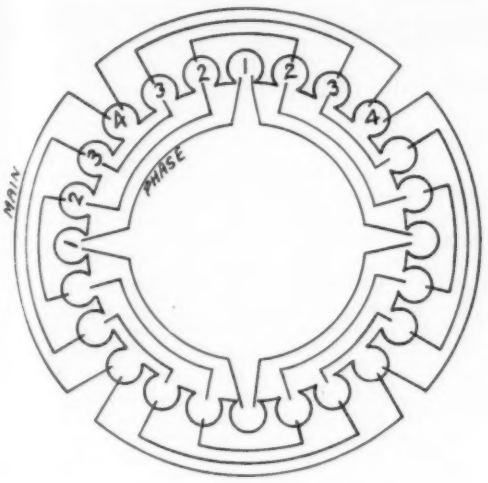
With a small file, carefully smooth the iron walls of the slots and remove all projections. It will be remembered that while punching the slots, no provision was made for opening them at the periphery of the bore. The slots are opened by a saw cut about 5/32 inch wide, made with two or three saw blades fastened side by side in the hacksaw frame.

The slot insulation consists of twenty-four troughs of thin sheet fiber or tough paper, one for each slot. These troughs of insulation should be long enough to project about ¼ inch on each end of the core. Each should be dipped in shellac before put in place.

The main winding is first to be placed. The winding on each pole consists of two and one-half coils, each consisting of 40 turns of No. 17 d.c.c. magnet wire, making a total of 100 turns per pole. The coils are wound as shown in the illustration Fig. 19. Slot (1) in the center of the pole is left vacant, the first coil of 40 turns commencing in slots (2-2), the second of 40 turns is wound in slots (3-3), and the third or half coil of 20 turns, is wound in slots (4-4). Between the parts of the winding on each pole, where they lap on the end of the core, a piece of fiber or other insulation should be inserted. Slots (2) and (3) each contain 40 turns of wire, while slot (4) contains only 20 turns, the remaining 20 turns which fill the slot being supplied by the winding on the adjacent pole. When all four poles are wound the coils should be connected so that if a direct current were flowing through them it would flow so as to magnetize the poles alternately north and south. If the coils are all wound in the same direction this may be effected by connecting the adjacent coils end to end and beginning to beginning.

(A) sliding loosly on the pins (B), and rotating with the rotor about the two insulated contacts (C) which are connected in series with the phase coils. Normally the two springs (D) hold the contactors against the contacts, closing the phase circuit until the speed of rotation reaches a predetermined value, when the centrifugal force of the contactors overcomes the tension of the spring and opens the phase circuit.

The phase cut-out parts are detailed in Fig. 21. The contact segments (A) are cut from a piece of copper or brass (B) and the lug is tapped for a small screw and bent back to the position at (A). Then cut the tube in two so that there will be a ⅛-inch air-gap on each side. These segments are mounted on the inside hub on one of the endplates which should be turned down smooth to receive them. The segments are insulated from the hub by means of several layers of thin fiber. A ⅛-inch machine screw binds each segment to the hub. Where the screw passes through the segment the hole should be enlarged to ¼ inch, and a fiber washer should be put under the head of the screw so that the screw will not ground the segment.



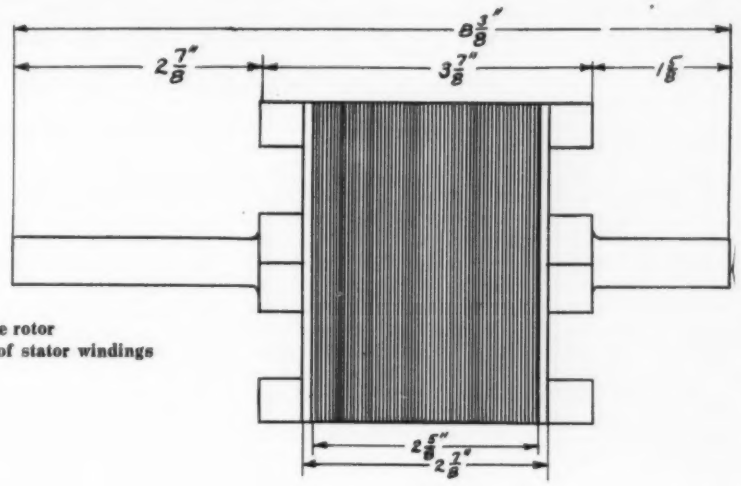


Fig. 18 (right)—Complete rotor
Fig. 19 (left)—Location of stator windings

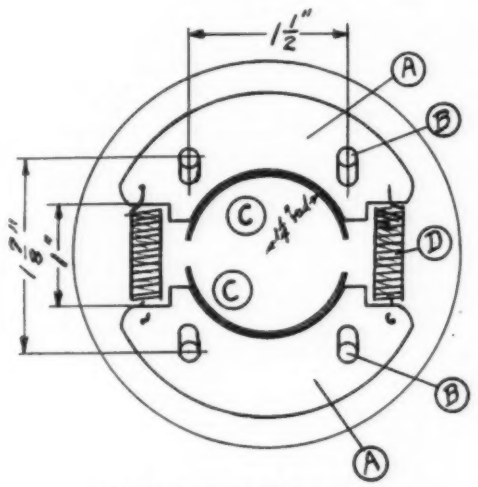


Fig. 20—Parts of starting device

The contactors (C) cut from some 1/16-inch sheet brass or copper. The slots (D) are 5/8 inches long, made by drilling two 3/16-inch holes with their centers 3/16 inches apart and then cutting out the material between with a small file. Be sure the edge (E) fits the curvature of the contact segments. The screw (F) is made from a piece of brass rod, and the nut (G), of 1/16-inch brass. It should be turned to within 3/32 inches of the head, after inserting the screw in the slot in the contactor, it should be secured with a drop of solder. Then drill and tap the holes for the screws in the rotor.

The springs are made by winding No. 22 brass spring wire around a 3/16-inch rod. Each spring measures ½ inch from end to end of the connections. The parts should be assembled as in Fig. 21. The connections of the coils are shown in Fig. 22.

It will be necessary to experiment with the springs until the contacts open the phase circuit at the proper speed which is 1,700 and 1,730 revolutions per minute. If the contactors open the circuit too soon, try a stronger spring, or if they do not open at all, the spring is too strong, and a weaker spring should be used, or weight should be added to the contacts in the form of drops of solder.

Figure 23 shows a cross-section of the assembled machine showing how the parts fit together.

A Theory of the Constitution and Mode of Action of Tannin Colloids

ALL vegetable tanning materials contain a peptiser and a peptisable substance, the proportions of which determine the colloidal properties of the aqueous extract. The tannin is the peptiser, the peptisable substances including polymerized tannin, ellagic acid, catechin, and phlobaphenes, according to the nature of the material. The peptiser forms a solid solution with the hide substance and plays a double role in the tanning process, first converting suspensions into colloidal emulsions, and then bringing the peptised particles to the fibril surfaces where the depeptization takes place. The resistance of the leather to water is in inverse proportion to the amount of peptizer taken up in the solid solution. The shape and size of tannin particles have an important influence on the yield of leather, and hide has a selective power with regard to sub-microns. The phenomena of tanning result solely from irreversible colloidal actions, there being no purely chemical changes. The ancient process of bark tanning is an example of slow peptization taking place during the tanning. By the use of liquors peptized matter is more regularly brought to the hide fibres, and in drum tannage this is not only accelerated but the peptized matter comes to the fibre in liquid form.—Note in *Jour. Soc. Chem. Ind.* in an article by W. MÖLLER in *Z. angew. Chem.*

The Lost Art of Close-Plating

CLOSE-PLATING, an art practised for centuries, is carried on now to a very limited extent, and will soon be classed as one of the "lost arts." Till recent times it was regarded as one of the most important industries,

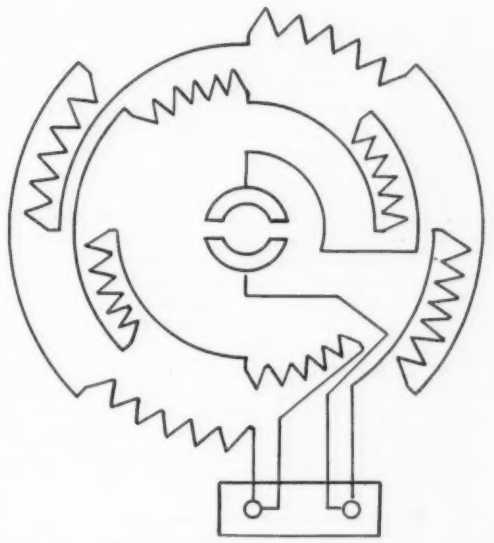


Fig. 22—Connection of windings

but it has gone down before the advance of electroplating. A few score years ago close-plating was the only method by which an article could be given the appearance of the precious metals, as all articles plated with either gold or silver were plated by this process. The massive door knobs, name plates, escutcheons, ornaments, and tableware found in colonial houses, that were not of solid gold or silver, were all close-plated. The process consists essentially in soldering on a carefully finished and tinned piece a thin sheet of soft silver shaped to fit the work. The silver sheet is stretched and worked into the crevices until it fits the part closely and then soldered. All these operations are performed with the simplest tools, but consummate skill and rare judgment are essential in the practice of the process.—*Keystone Weekly.*

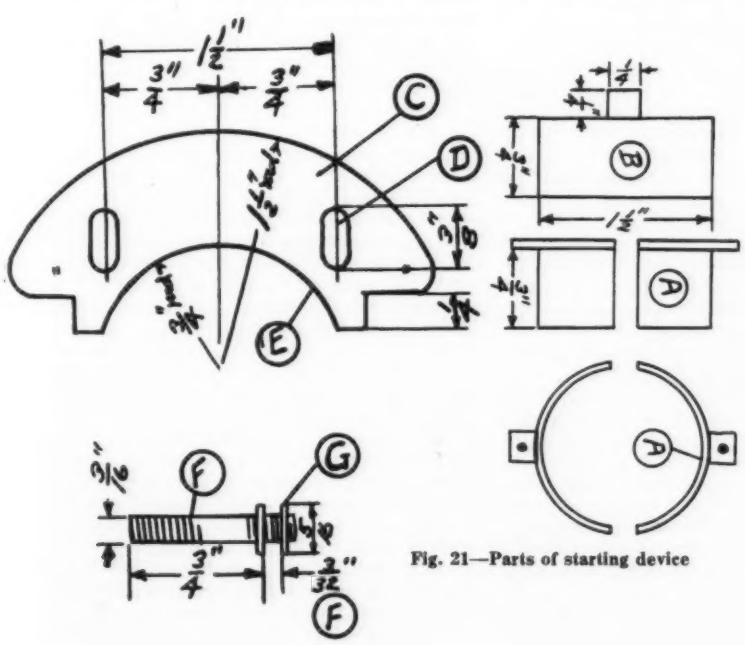


Fig. 21—Parts of starting device

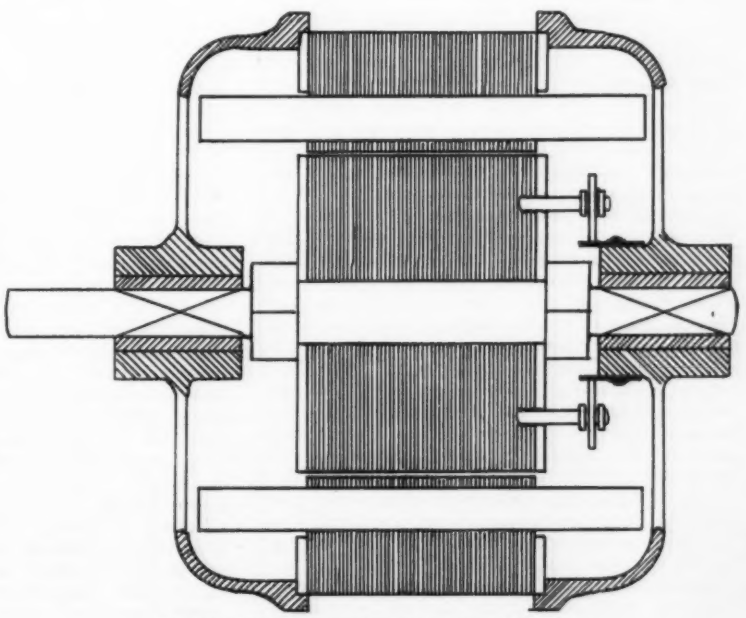


Fig. 23—Section through parts of assembled motor

Precision in Chemical Weighing—I*

Notes on the Apparatus To Be Employed and Methods of Using It

By William Norman Rae and Joseph Reilly

THE facility with which accuracy can be obtained in weighing depends to a large extent on having a good balance properly erected and carefully adjusted. To introduce our subject with at least a brief discussion on these points will not be out of place. The balance room calls for first consideration.

The chief requirements of a balance room are a uniform temperature, good lighting, and freedom from draughts and direct sunshine. If the room is lighted from the north and the balances are placed along the south wall the light falls on the scale and enables it to be seen distinctly, while any radiation from outside falls equally on the two arms, and so is less likely to produce disturbing effects. It is a disadvantage to have the balance table against the outer wall, as the disturbing effects due to bad weather are more pronounced. The desirability of a uniform temperature will be clear from what follows, and in this connection double doors and windows are a distinct advantage. Since a rigid table is essential for accurate work the balance tables are best made entirely of reinforced concrete or of slate slabs supported on brick pillars built up from the floor. If the room is upstairs the supports can be built out from the wall.

For work of the highest accuracy different workers have used various devices. Brauner covered his balance with a thick layer of flannel to shield it from radiation; Briscoe and Little supported the levelling screws of the case on glass plates standing on packets of filter-paper on the stone slab to deaden the effect of vibration of the building (large rubber stoppers can be used for the same purpose); Edgar and Dixon used a cellar as balance room; Manley used a room with a north-east aspect, but it was darkened and then illuminated with artificial yellow light—his balances were placed in steady temperature cupboards built up of plate glass, asbestos, and cotton wool. Crookes was one of the first workers to realize the importance of these factors. The balance he used in the determination of the atomic weight of thallium was kept in a dry room of uniform temperature, free from draughts, artificial heat, or vapors. In other instances he enclosed the balance (an Oertling) in a cast-iron case and regulated the conditions of the air surrounding the balance as required (see *Proc. Roy. Soc.*, 1872). In these latter experiments, as in the case of Manley's, the balance room, or rather the interior of the iron case containing the balance, was dark. The scale was illuminated by a small electric vacuum tube and the readings taken from a distance by a telescope.

THE CHEMICAL BALANCE

It can readily be shown theoretically that the sensitiveness of a balance is increased by having a long beam, by reducing the mass of the beam, by making the distance of the centre of gravity below the central knife-edge small, and also by use of a long pointer. These conditions, while increasing the sensitiveness, at the same time increase the time of vibration of the beam, and therefore the time occupied in weighing. In general, therefor, a compromise has to be made—some of the sensitiveness has to be sacrified to reduce the time of swing.

In precision balances, one of the quantities above mentioned—namely, the distance of the centre of gravity below the central knife-edge—is made variable by means of the gravity bob, a nut with milled edges moving on a screw vertically above the center of the beam and held in position when the required adjustment is made by a locking nut. As the gravity bob is moved up the sensitiveness and time of swing both increase, while if it is put up too high the equilibrium becomes unstable. With long beam balances a time of vibration of about sixty seconds is convenient, while with short beam balances it may be reduced to as low as ten seconds. To get the required length of beam together with proper rigidity, but yet without making the beam unduly heavy, a light framework is used instead of a solid bar; this is usually either triangular in shape or may take the form of a girder with a web of light bars. The use of very long beams is not now so popular as it was, because equal sensitiveness with a shorter time of swing can be secured with a short beam and a long pointer. It is recognised, however, that any slight errors in the adjustment of the knife-edges produce greater effects with short than with long beams; in fact it was only by improving these adjustments that the short beam balance became possible.

The three knife-edges should be exactly parallel, and in general are so arranged that they all lie in the same plane, with no load on the balance. If the beam were perfectly rigid the edges would remain coplanar for all loads; in most balances this is not so, and the two end knife-edges fall below the central one for heavy loads. In some cases the beam as a whole may be rigid, but the end knife-edges are carried on light metal projections, which are more easily deflected.

It is sometimes arranged that the terminal knife-edges are above the central one for small loads; then as the load is increased the beam bends slightly, so that the three edges become coplanar, and then with still greater loads the terminal ones fall below the central one. The sensitiveness then increases with the load until the knife-edges are in the same plane and then decreases, thus giving maximum sensitiveness at medium loads. Proctor states that unstable equilibrium is likely to result when the terminal knife-edges are above the central one.

The center of gravity of the weights and scale pans should always be vertically below the knife-edges; this result is attained by having a loose link between the stirrup and the scale pan, and also by taking care to place the weights centrally on the pan. In some of the best balances the center of gravity of the pan and its contents is brought below the center of support as follows:—Two knife-edges are provided at right angles to one another. One of these is the ordinary knife-edge of the beam, the other is usually of cruder construction made of metal. This gives a support as nearly frictionless as possible, with freedom in both vertical planes.

The method of fastening the knife-edges to the beam is important, but will only briefly be considered here. Various devices have been used to ensure that the knife-edges and planes are always working in the same relative position—*i. e.*, that release and arrestment do not interfere with their accuracy. Without considering in detail the subject of geometrical slides a reference may be made to the Kelvin "point line and plane" as an example. This device gives a constant relative position despite expansion. In some balances the point line and plane are of metal, in the best they are of agate.

At the center the frame has two slots, which catch corresponding projections on the bar carrying the central knife-edge, while at each end are two screws with fine points, which engage respectively with a cone and slot on the stirrup which bears the agate plane and the pan. From the back of the plate fixed to the central column rises a short rod, to which is attached the horizontal rod bearing the central agate plane. The arrestment is raised by turning a handle or milled head attached to a horizontal rod which bears two eccentric disks; on one of these rests the end of the sliding rod or a small wheel attached to it, while the other eccentric operates the levers which raise or lower the pan supports. When the arrestment is released the central knife-edge rises just clear of the plane, and at the same time the end planes are lifted from their knife-edges and the pan supports rise and catch the pans. Generally the handle for arresting the beam is in front, although in some balances not of the greatest delicacy it is very conveniently placed at the side to be operated by the left hand, leaving more space for the right hand to add the weights. The method of raising the arrestment rather than the beam is much to be preferred: it makes it easy to start the balance swinging with a small amplitude and avoids disturbing the air to any extent by the motion of the pans.

The pointer is attached to the center of the beam and tapers to a fine point where it traverses the scale. In some cases the scale divisions are carried to the top of the scale, and the end of the pointer then moves in the plane of the front of the scale and just over the top of it. Generally the fine end of the pointer moves over the front of the scale and very close to it to avoid parallax in reading its position. Another device sometimes used consists of a small rectangular frame bearing a thin cross wire and fastened to the end of the pointer; the movement of the cross wire is observed through a microscope fixed in the case. With the standard mark on the pointer the reading is dependent on the foscussing of the microscope, and this would restrict the range of swing. With the following device for magnifying the range of the pointer this difficulty is overcome. A micro scale is mounted on the pointer upside down. This is observed through a microscope with a spider web in the eyepiece. The magnifying mirror used by Bunge and Kuhlmann is so arranged that it leads to either increased sensitiveness or to reduced time in weighing or to both. A low sensitiveness balance with a microscope is preferred by most workers to the same balance adjusted to a greater sensitiveness and without a microscope.

On the beam itself is the rider scale. The top of the scale is best arranged so that it lies in the same horizontal plane as the three knife-edges. It is a common practice, however, to have the scale above this plane but parallel to it, or even to use the top bar of the beam as the scale, in which case the scale is often not horizontal. The effect of having the scale in a horizontal plane above the knife-edges is to increase the sensitiveness when the rider is put on, but the sensitiveness is not altered by moving the rider from one scale division to another. The effect can be nullified in such a case by placing the rider at the center of the scale—*i. e.*, directly over the central knife-edge, when it is not being used, instead of raising it off the scale, as is commonly done. In the last case, when the scale is not horizontal when the beam is at rest, the sensitiveness will rise as the rider is moved from the end of the scale towards the center. The first arrangement is therefore preferable, because the addition or removal of the rider has no effect on the sensitiveness. The effect is a small one, owing to the small mass of the rider, and is only important in very accurate work.

In most chemical work we are only concerned with relative weights, and therefore any inequalities in the lengths of the two arms of the beam are of no importance. When necessary the ratio of the lengths of the arms can be obtained, and also, assuming that the weights are accurate, the true weight of the body, by using Gauss's method. The body is first weighed in the left pan (apparent weight say X) and then in the right pan (apparent weight say Y); then, if L and R are the lengths of the arms and M the true weight of the body, by taking moments about the center of the beam in the two cases—

$$M \times L = X \times R$$

and $$Y \times L = M \times R,$$

from which $$L/R = X/Y,$$

and $$M^2 = xy$$

$$M = \sqrt{xy}.$$

In general no appreciable error is caused by taking—

$$M = \frac{X+Y}{2}$$

The value of L/R on a good balance is usually very near to 1; the actual value in the case of an Oertling balance used by one of us, is 1.00003. The value of the ratio can be altered by shifting the position of one of the knife-edges by means of the screws provided. It should be emphasized that such adjustments should only be made by a good instrument maker. The effect of even a very small alteration in the distance causes a big error in the weighing. The difference of the apparent weight in the two scale pans is the reason for always placing the object to be weighed in the left pan. Another method of obtaining the true weight of a body is by using two sets of weights, A and B, in the following manner:—Place the object on the left pan and balance it with the weights A, remove the object from the left pan and replace it by the weights B until balance is again obtained: the object and the weights B have now been balanced against the weights A under identical conditions, and the object therefore has a mass equal to that of the weights B used. The method of standardizing weights as given by Sir William Crookes (*Proc. Royal Soc.*, 1872) we have found to work quite satisfactorily (see *Chem. News*, April 19, 1867, for complete details).

WEIGHING

It is often useless to weigh with very great accuracy; *e. g.*, large pieces of rubber, coal, glass, or platinum often change in weight by some mgrms. in successive weighings. This variation is especially noticed in the weighing of finely divided coal, and several authorities state that in such weighings no desiccating agent should be used in the balance case. In instances like the above the following method of weighing is rapid and satisfactory:—A table is first constructed showing the sensitiveness with various loads. Before the weighing is commenced the pans are wiped with a small camel-hair brush, the case is closed and the beam is carefully released, when the pointer will swing slowly backwards and forwards over the scale (with a little practice this can be done so as to give the pointer any desired amplitude). When the amplitude has fallen to about five scale divisions the readings of the extremities of the swing are taken for five successive swings, the observer sitting directly in front of the balance to avoid parallax in the readings. The first two or three swings are always neglected, to allow the beam to settle down to a steady condition. It is best to number the scale continuously from left to right rather than to call the center division 0 and those to the right positive and to the left negative. Suppose the middle

*From *The Chemical News*.

point of the scale to be numbered 10, and that the following numbers represent the turning points observed in an experiment:—

	Left	Right
	9.0	
		11.0
	9.1	
		10.9
	9.2	
		10.95
Mean	9.10	

$$\text{Resting-point} = \frac{9.10+10.95}{2} = 10.03$$

The pointer is sometimes viewed through a convex lens placed in front of the scale to magnify the divisions, but this is likely to increase the error due to parallax between the pointer and the scale. When the readings of the turning points have been taken the beam is arrested, care being taken that this is done at the instant the pointer is at the center of the scale. In this way jarring the knife-edges is avoided; their movement over the planes is also avoided, owing to the fact that while the arrestment pins move vertically the ends of the beam move in the arcs of a circle. The 10 mgrm. rider is now placed on the first division of the scale, with the effect of adding 1 mgrm. to one pan, and the new resting point is found in the same way as the former one. Suppose the value 6.29 is found; this means that the addition of 1 mgrm. shifts the resting point from 10.03 to 6.29, or the sensitiveness with no load is 10.03–6.29, *i. e.*, 3.74. The process is then repeated with 10, 20, 30, etc., grms. on each pan, and from the results obtained a curve is constructed with the sensitiveness plotted against the weights.

Damping is of little importance in calculating the resting point, and will only be briefly considered. If *a*, *b*, *c*, etc., be three successive turning points:—

$$a$$
$$b$$
$$c$$
$$d$$
$$e$$
$$\&c.,$$

$$\text{then R.P.} = \frac{a+2b+c}{2} = \frac{a+3b+3c+d}{8}, \ \&c.$$

The R.P. in above illustration turns out to be 10.02 instead of 10.03.

We have—

$$b = ae-\delta$$
$$c = ae-2\delta,$$

or—

$$a$$
$$a-\delta$$
$$a-2\delta$$
$$d-3\delta$$
$$e-4\delta$$

and hence formulæ.

To weigh an object the method of procedure is as follows:—The object is removed from the desiccator and left in the balance case for twenty minutes. The beam is then released, and the zero determined by the method of oscilations. The object is placed on the left-hand pan, and a large weight is put on the right-hand pan (the weights should be put as near to the center of the pan as possible, or on releasing the beam the pan will be set in vibration which takes some time to die down), and the handle is turned slightly but only just far enough to see in which direction the beam is going to move; it is unnecessary to completely release the beam. Should the weight be too large the beam is arrested, the weight removed, and the next smaller one is tried, trying each weight in turn until as near as possible equilibrium has been obtained. When this has been done the rider is placed at the sixth division on the scale and tried; if it proves too much it is next tried at a second division, or if too small, at the fourth, and so on until the weight to the nearest mgrm. is found. The beam is then released so that it swings with a small amplitude and the turning point of five swings are taken, and from these the rest point (R.P.) is deduced. Sufficient data have now been obtained to ascertain the weight of the object. The method of calculating the exact weight is made clear by the following example:—

Determination of the zero:—

Turning points—

	Left.	Right
	9.0	
		11.0
	9.1	
		10.9
	9.2	
Mean	9.1	10.95

R.P. 10.03.

With the object on the left pan and 20.57 grms. on the right and the rider on the seventh scale division:—

Turning points—

	Left	Right
	9.5	
		12.1
	9.5	
		12.0
	9.6	
Mean	9.53	12.05

$$\text{R.P.} = \frac{9.53+12.05}{2} = 10.79.$$

From the sensitiveness curve the sensitiveness for 20 grms. is found to be 3.70.

The R.P. has changed from 10.03 to 10.79; *i. e.*, 0.76 divisions.

A charge of 3.70 is the effect of 0.001 grm.

" 1.00 " $\frac{0.001}{3.70}$ grm.

" 0.76 " $\frac{0.001\times0.76}{3.70}$ grm. = 0.0002 grm.

Since the resting point obtained with the weights on the pan was greater than the zero, the weights were insufficient, and the 0.0002 grm. must be added to the 20.577 grms.; the total weight is thus 20.5772 grms. If the weight is large it is worth while taking the zero after the weighing as well as before and using the mean of the two values.

TEMPERATURE MUST BE OBSERVED

A centigrade thermometer reading to 0.1 should be kept in the balance case and its reading taken each time a weighing is made; the barometric height should also be recorded; these are required for the vacuum corrections (see later).

Objects must never be weighed until they are at the same temperature as the balance case. Mellor mentions that a platinum crucible weighing 20 grms. appeared to weigh 0.04 grm. heavier cold than when weighed warm. A tentative suggestion is, that owing chiefly to convection currents being set up by the hot body and these acting on that side of the beam, raises it and so makes the object appear too light. A platinum crucible, after heating, should be allowed to remain for twenty minutes in the desiccator and ten minutes in the balance case, whereas a procelain crucible, *e. g.*, a Gooch, really requires an hour to reach equilibrium; but this may be shortened to half-an-hour, provided the same time is allowed to elapse throughout any series of experiments.

Stas and also Smith state that large flasks after heating or rubbing required six hours to attain this equilibrium; polished platinum reaches a steady state very quickly, while roughened platinum surfaces may take longer than porcelain or glass. Except in work of the highest accuracy this long time is not allowed, a period of about twenty minutes sufficing, in which time the greater part of the change will have occurred, and if exactly the same time period is allowed each time the resulting error will be small.

Some authors—*e. g.*, T. W. Richards, Steel, and Grant—recommend the use of a small quantity of uranium oxide in the case to dispel electric charges produced on glass or quartz apparatus in the process of wiping preparatory to weighing. Glass or quartz weights, it is claimed, become electrified by friction with the velvet lining of the weight-box, and such charged bodies would be attracted by near objects, but it is unlikely that this factor will cause even a small error in weighing.

The authors have noticed that fine powders which have been heated, *e. g.*, precipitated silica, and also Gooch crucibles, steadily gain in weight when transferred from the desiccator to the balance case; this is due to the absorption of moisture and may amount to several mgrms. In weighing an anhydrous powder, therefore, the operations should be carried out as quickly as possible. It may facilitate matters to some extent if the large weights are placed on the pan before the vessel containing the powder is added; *e. g.*, if a crucible weighing 25 grms. is being used and the weight of the powder is estimated to be 2 grms., 27 grms. may be placed on the pan in readiness. If the object is of such a size that it will conveniently go into a stoppered containing vessel, this can be used with advantage; the vessel being placed in the desiccator with the crucible or boat, and the latter when cooled being placed in the stoppered vessel and transferred to the balance, left the usual twenty minutes to approach equilibrium, and then weighed. The same procedure of course must be adopted in obtaining the weight of the empty boat or crucible.

Powders should be weighed in glass stoppered weighing bottles and then transferred to the reaction vessel, the bottle and the remaining powder being weighed afterwards, the weight of the powder being obtained by difference. Salts containing water of crystallization should not be placed in the desiccator previous to weighing but should be weighed air dry. Liquids will evaporate in the balance case, and are therefore weighed in stoppered vessels or in one of the numerous weighing pipettes made for the purpose.

When large glass or porcelain vessels have to be weighed, Borda's method of weighing by tares is useful because in these cases the vacuum corrections would otherwise be large, and owing to their uncertainty may cause large errors. (See below). In Borda's method the zero is first determined as usual, and the object to be weighed is placed on the left pan; the tare should be of the same material and of nearly the same weight, volume, and surface area as the object; the tare is placed on the right pan, and small weights are added to one pan to get equilibrium, and the R. P. is calculated. From this we get that the object is equal to the tare, or a small weight "w." After the reaction the object is again weighed against the same tare, and the alteration in weight is thus determined. The tare should receive exactly the same treatment as the object weighed; *i. e.*, if the latter is heated to redness and then cooled in the desiccator for half-an-hour, the tare must be similarly heated and cooled.

The above methods of weighing are sufficiently accurate for all ordinary laboratory work, but when greater accuracy is required greater precautions must be taken. Probably the disturbing effects of temperature are the cause of most of the difficulties. In the first place, inequalities of temperature will cause convection currents, which may make it difficult to get a constant zero, or by acting on one arm of the beam more than the other may cause an object to appear heavier or lighter than it really is. In the second place, a change of temperature will alter the lengths of the two arms of the balance, and although these are constructed of the same material their expansion coefficients may not be quite the same. One effect of this is the change in the zero which takes place throughout the day; this has been observed by many workers. Poynting noticed it in the case of an Oertling vacuum balance which was covered with felt and then with well polished tin, leaving only a small window for the observation of the pointer. The change was found to follow the temperature of the balance-room. The same trouble was encountered in his experiments on the determination of the mean density of the earth. We have carried out some experiments in which the balance was first used in a room in which most of the radiation fell on the side. Observations on the unloaded balance showed that the zero shifted an amount corresponding to an apparent weight change of 0.2 mgrm. between 9 A. M., and 3 P. M., while the temperature of the balance room was rising, and when the latter began to fall the zero started to creep back, but on the next morning it had quite recovered. The balance was then turned through an angle of 180°, and after leaving twenty-four hours to settle down the observations were repeated with the same results. The position of the zero again rising from scale division 10 to 12 in the morning, and commencing to fall towards the evening, although the radiation now fell chiefly on the opposite side. The same result is obtained with the pans loaded. The result of a change in the ratio of the arms can be found for different temperatures and an allowance made for it when weighings are made of the same object at slightly different temperatures. This source of trouble is much aggravated by large changes of temperature, and shows the importance of a steady temperature in the balance room and of reading the temperature of the balance case each time a weighing is made or the zero determined.

Besides this gradual change of the zero a temporary change may be produced by the unequal heating of the beam by the operator's hand in loading the balance. This point has been very thoroughly investigated by Manley (*Phil. Trans.*, A, ccx., 407), who found that great improvement in this respect was brought about by enclosing the beam in a protecting case within the ordinary case. Manley showed that within an ordinary balance case when the balance is in use that there is a constant fluctuation in temperature to the extent of 0.2° C. in the neighborhood of the beam. Adopting a protecting case uniformity in the temperature of the enclosed balance beam is obtained. The covering acts in addition as a dust-proof case. Landolt was also well aware of the disturbances caused by slight temperature changes in the balance case, and in his experiments on the constancy of mass in chemical reactions took his readings and also loaded the balance and interchanged the contents of the pans from a distance of three meters. In addition most of his weighings were taken at a standard temperature approximately 19° applying a small correction calculated from the known temperature coefficient of his balance when the temperature at the time of weighing deviated from 19°. It is instructive for a person to try a few experiments with a sensitive balance, weighing the same object repeatedly and consecutively without altering the balance, and also

to weigh the same object at different times of the day. The effect of altering the position of the worker in weighing could also be noticed. In the above cases it is quite usual to get quite appreciable variations.

If the balance is loaded and the beam released so as to swing with a large amplitude, readings can be taken of the turning-points until the pointer practically comes to rest and the R.P. can be calculated for various amplitudes. It is always advisable to neglect the first few swings, when the beam may be supposed to be in a disturbed state due to the three knife-edges not being released at exactly the same instant. Irregular values of the R.P. are found with large amplitudes, but the value tends to become steady when the amplitudes do not exceed five divisions. Manley ascribes this to a slight lateral shift of the knife-edges, which is more pronounced unless the latter are attached by the method mentioned above.

[TO BE CONTINUED]

Conversion of Fruits and Vegetables Into Dried Products

IN the case of pears and apples, the best results were obtained by subjecting the peeled and halved fruits to the action of sulphur dioxide for 10-15 minutes, followed by treatment with steam for 5-10 minutes, and then drying them at 80°-90° C. for 8 hours. Stoned peaches and apricots were sulphured for 15 minutes and then dried at 80°-90° C. for 8 hours. Plums were steamed for 90 seconds, or immersed in boiling 5 per cent potassium carbonate solution and then rinsed in cold water; they were dried first at 50° C., then at 70° C., and finally at 90° C. Good results were obtained by either treatment. Cherries were steamed for 5 minutes and then dried at 85° C. for 12 hours, whilst figs were peeled, cut in halves, then treated with sulphur dioxide for 30 minutes and dried at 50° C. for two or three days. Vegetables, including potatoes, carrots, cabbage, cauliflower, spinach, celery, peas, beans, onions, leeks, turnips, and turnip tops were scalded or steamed and then dried at 40° to 60° C.—*Note from the Journal of the Society of Chemical Industry on a paper by* V. VALVASSORI, *in Bulletin Agricultural Intell.*

Voice Recovery After Shell Shock*

MY first acquaintance with these cases was at the Highbury V.A.D. Hospital, where I used to arrange musical entertainments for the men. I was asked to see a patient of Capt. Stanley Barnes, who had entirely lost his voice as a result of a shot through the neck. I put him through a course of instruction, and he was beginning to recover his voice when, unfortunately, he passed from under my care, and I lost sight of him. However, since then, I have had under treatment a considerable number of cases at the First Southern General Hospital, Bournbrook, and my experience may be of use as a teacher of voice production, both for the singing and speaking voice. I was well acquaintaned with its mechanism, and I was familiar with the several troubles commonly met with in ordinary times; but these cases arising from the war presented many novel features, the treatment of which had to be largely experimental, and the cases presented many points of similarity and also of dissimilarity. The patient would be absolutely mute, but able to write intelligent answers to questions. Mostly he appeared to have lost entirely the subconscious memory of how to form articulate sounds. In the Highbury case there was an actual wound, but generally it is otherwise. Shell-shock may be described in this way. A high explosive shell bursts near the trench; the men are protected from the fragments, and also to a large extent from the air concussion; but they are buried under the ruins of the parapet. When dug out some hour or two later they are unconscious, and have no recollections of what has happened to them—that is, if they have been rendered entirely unconscious. If only partially buried they endure tortures of anticipation. An X-ray examination shows that the diaphragm is drawn up to its highest point and rigidly fixed there. Now any shock less has the effect of raising the diaphragm, and in these cases everything round the top of the chest is rigid and constricted, the abdominal muscles are very tight and digestion suffers, and vomiting may be frequent for a great number of weeks, or even months, and in most cases the other bodily functions are interfered with. The actual seat of injury is the speech center at the back of the brain. The breathing nerves and muscles get out of gear, and there is no breath control. Inhalation is by spasms, and the vocal chords lie wide apart and paralyzed. There is probably some determination of brain substance, and hysteria often supervenes, but hysterial aphonia does not necessarily indicate any physical injury. (For instance, the smell of hyacinths will frequently upset a singer's voice for the time being.) Sometimes patients who cannot speak voluntarily will mutter a few words in sleep, generally when they are in a fair way to recovery.

Mutism is caused, in the absence of direct injury, by the loss of the control of the breath during exhalation, and the restoration of the diaphragm to a normal state is a necessary but tedious process. The first thing is to attend to the general health, and particularly the nerves. The patient is kept quietly in bed. This part of the treatment is, of course, the work of the physician and sister-in-charge entirely, and does not come within my province. As the first direct exercise a hand is placed on the patient's abdomen, and the other over his mouth, and he is told to try and take breath. The expulsion of the breath is assisted by pressure on the the abdomen. A cigarette-holder between the lips is useful as it limits the amount of breath passing and prevents gasping. Inside the mouth everything is disorganized. The tongue is in constant and violent motion, which is communicated to the larynx. The soft palate and uvula drop, and the back of the tongue rises, so that the opening of the pharynx is obstructed; and the patient has no control of the lips, so that the mouth may open sideways or any way. We next aim at getting control of the soft palate and mouth, and the patient exercises the latter before a looking-glass. After a time the tip of the tongue may be induced to lie in place, but the back of the tongue may remain too high. Now stand up and open the mouth, put the tongue well forward and slowly draw it back. Open the mouth, take breath very slowly, allowing the air to beat on the soft palate, and it will have the effect of raising it, but all this must be done very gently and takes considerable time and patience. When the lips, tongue and soft palate have become somewhat normal, we can begin to co-ordinate. If, as is probable, the vocal chords lie far apart, we must begin with some consonants. Probably at first the patient will not be able to give a puff from the mouth, but only from the chest, in which case we may begin with a spitting action until control of the lips is recovered. Then we try a P sound, practically a puff from the lips; then a T from the tip of the tongue against the upper teeth. For F bite the under lip and blow. It is well to take the thin consonants, like P T F, before the heavy, like B D V. Trouble is found with the S and Sh, which the patient cannot easily distinguish. Put the hands firmly over the ears, and make these two sounds, when S will be perceived to come from the very front of the mouth and Sh from the back. In this way the subconsciousness is built up. M is treated in somewhat the same way. Hands over ears, and give the lightest possible hum. If the back teeth are closed the tone will be too far back. When a man can hum he is fairly on the road to recovery. N follows, with chest rigid. If he cannot sound N he cannot cough. Let him try to clear his throat. Open mouth quietly, take breath. think of N, and cough slightly to vibrate vocal chords. Next we may take W for lip practice; say Wa to get lips forward and back; also let him try to whistle, which he will not do without effort.

So far the patient may have got, and still only be able to whisper, but should the voice by this time begin to come we may proceed to the vowels. Ah, is the best to start with for opening the throat and vibrating the vocal chords. Open the mouth, take breath, and think of the sound required, and perhpas give a little cough to start the vibration. We follow on with other vowels. Au is deeper and steadier on the chest. If the larynx is too high trouble follows, and the Au sounds tend to drop it, so we use All, Tall, Fall, etc. Our long I, as in Idle, Ice, Idea, Tie, is still deeper; the vibration of the chords is the same as in Ah, but the mouth is less open. O as in Go, No, Roll, and Oi as in Oil, Toil, Boy, are very good. The shorter vowels give great trouble to Midlanders, who naturally clip and mispronounce them terribly. Vocally there is no such thing as a short vowel. The word Dog may be set and sung accurately to any length of note. Birmingham tends to turn short a into ai. Sheffield choirs will always be more sonorous than Midland, because they naturally sing an open A, while we as naturally clip it. Try Rare, Bare, Any, Many. Judicious humming is always helpful. With L, as in Billiards, there is a tendency for the tongue to set tight at the top, and so make the larynx rigid. Very awkward letters are our short 3 and i, largely from our habit of clipping them. The mouth is liable to draw sideways and get tight. Try pushing the lips a little forward, like an Italian, instead of drawing them in.

Having got thus far, we may proceed to the coördination of consonants, like Pr, Tr, St, Sp. When memory begins to reassert itself the rest is largely a matter of practice and concentration of attention on the part of the patient, aided largely by the return of health.

We shall be fortunate if we have got to this stage in two or three months; indeed, very rapid progress is undesirable, as it is usually accompanied by very bad stammering. We hear of lost voices being recovered as the result of a shock, but I cannot recommend the treatment. The patients are very "jumpy," and I find it necessary to avoid most carefully the banging of a door or other sudden noise. One patient, who had been a good tenor singer, and seemed pretty well restored, was sent to Ireland, where he joined a concert party, and for a time seemed all right; but the nervous strain was too great for him. One day he got into a strong argument with another patient, fell into a trembling fit, and lost his voice again, and the tremors of his limbs also returned.

In conclusion, I must impress upon you the importance of the diaphragm in all breathing exercises. In mute cases if we can once recover its use all is likely to go well. The other points to be attended to are the stability of the chest, tongue drill, and humming exercises, and, above all, patience alike on the part of the patient and the teacher.

*Abstract of an address to the Birmingham and Midland Institute Scientific Society by Mr. J. L. Robinson. Republished from the *English Mechanic*.

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